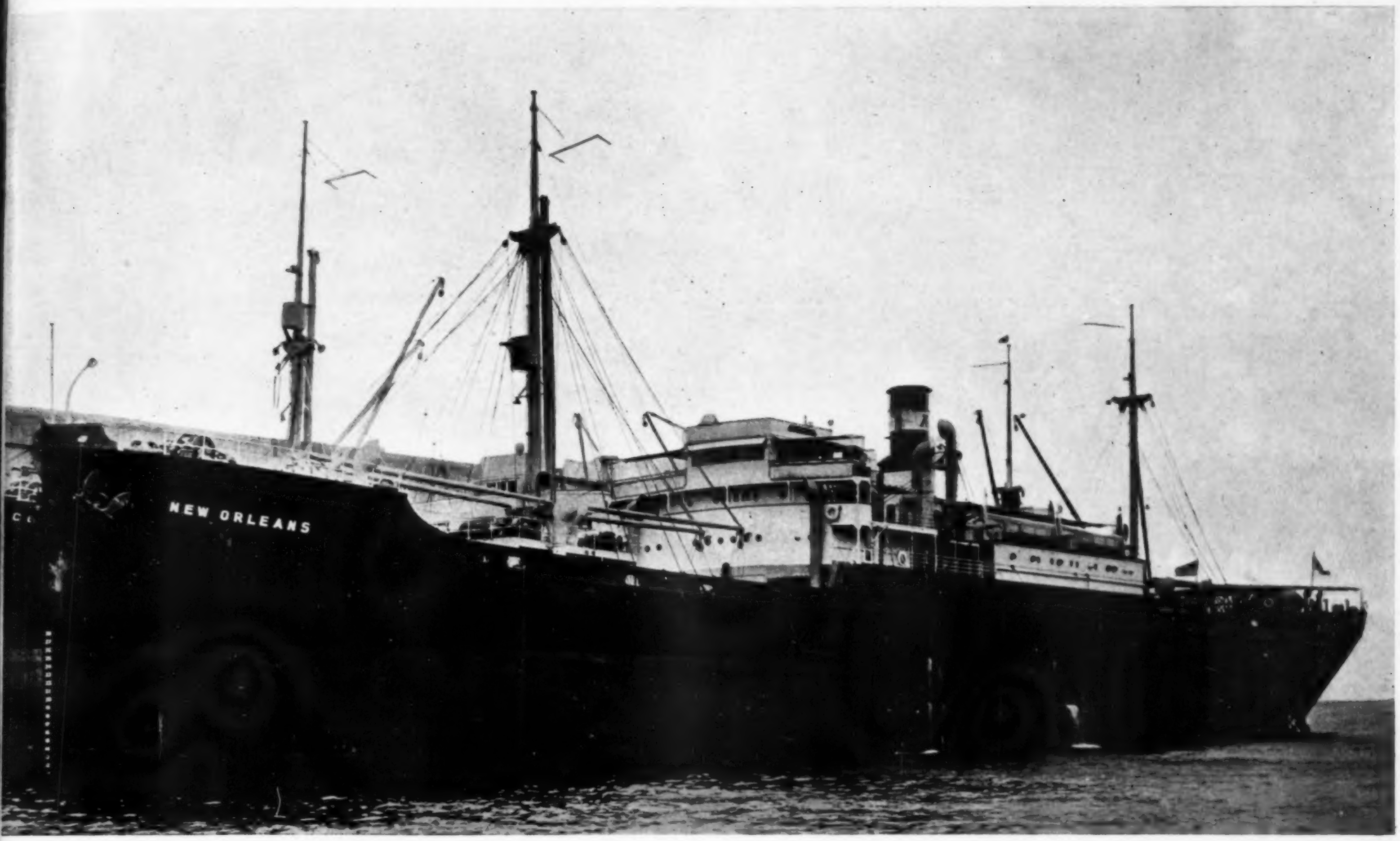
DIESEL PROGRESS

IN INDUSTRY • IN TRANSPORTATION • ON THE SEA • IN THE AIR

JULY, 1935 CIRCULATION OF THIS ISSUE—IN EXCESS OF 10,000 COPIES 25c

Outstanding DIESEL *Achievements*



THE *New Orleans* and the *Wichita,* converted to Diesel drive by the Shipping Board in 1929, have rolled up an impressive, if unsung, record for themselves. Six years of consistent, economical service, with not a single forced stop at sea for machinery trouble, the *New Orleans* has travelled 350,000 miles and the *Wichita* 370,000 miles. Powered with four-cylinder, 4,000 hp., double acting, two-cycle HAMILTON-M.A.N. Diesel engines. These two vessels represent an outstanding Diesel achievement — splendidly carrying out the tradition of the Hamilton Shops from which came their engines.

HAMILTON-M.A.N.

THE HOOVEN, OWENS, RENTSCHLER COMPANY
HAMILTON, OHIO
Division General Machinery Corporation

NEW ORLEANS — WICHITA

Length	411' 9"
Beam	55'
Depth	34' 11"
Draft	27' ¼"
Tonnage	9,100

Average speed 13 knots. Operated by American Pioneer Line. Each vessel powered with a four-cylinder, two-cycle, 4,000 hp., double acting HAMILTON-M.A.N. Diesel engine operating at 103 rpm.

DIESEL PROGRESS for July, 1935. Volume I, No. 3. DIESEL PROGRESS is published monthly by Diesel Engines, Inc., 2 West Forty-fifth Street, New York, N. Y. Rex W. Wadman, President. Acceptance under the Act of June 5, 1934, at Brooklyn, New York, authorized May 14, 1935. Subscription rates: United States and Pan American countries $3.00, Canada and all other countries $5.00 per year. Single copy price 25 cents in U. S. A., 50 cents for all other countries.

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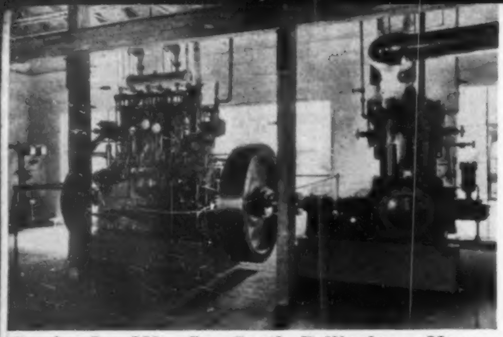
Editor and Publisher..............REX W. WADMAN
Managing Editor.......... FRANK M. PRENDERGAST



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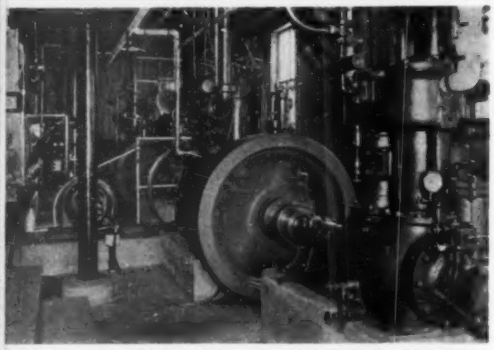

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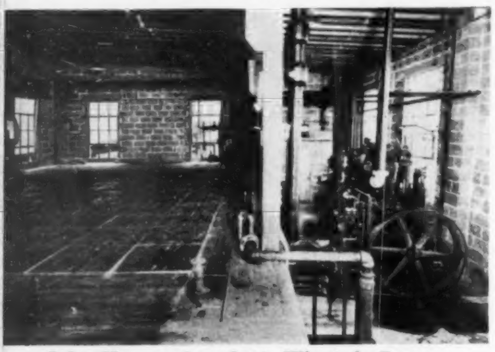

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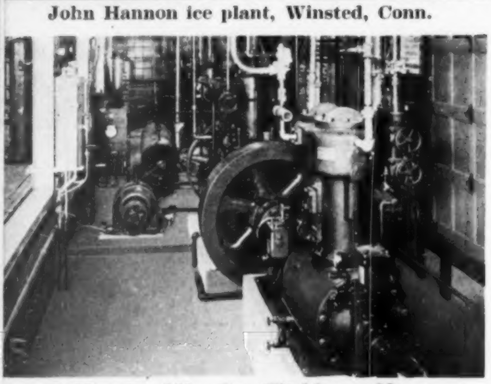

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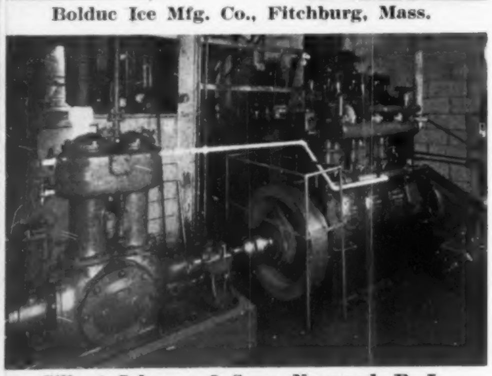
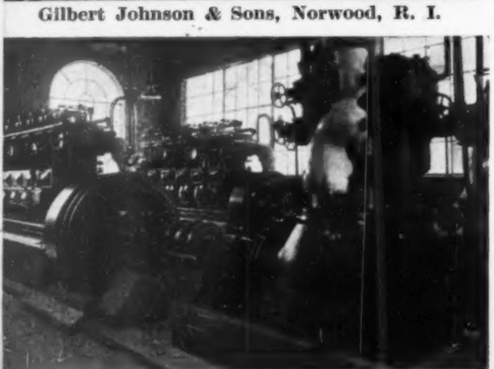


Gilbert Johnson & Sons, Norwood, R. I.



W. B. Chaffee ice plant, Providence, R. I.

IN NEW ENGLAND THEY USE ATLAS DIESELS

IN conservative New England, where every business venture receives the closest scrutiny, that is where ICE and REFRIGERATION PLANTS have been quick to take advantage of the economies of DIESEL POWER.

Facing keen competition from natural ice produced at low cost, they are throwing off the yoke of high electric rates and are converting their plants to ATLAS DIESEL POWER . . . and cutting their power bills in half.

Under normal operating conditions of 20 pounds suction pressure, 185 pounds condensing pressure, and can water at 70°, the average electric driven plant in a temperate climate will use about 53 kilowatt hours per ton of ice produced. If electric power is purchased at 1½ cents per kwh., including demand or standby charge, the power cost is 79½ cents per ton.

There are in operation today many ice plants as small as 20 tons rated daily capacity which, under the same operating conditions, make a ton of ice with ATLAS DIESELS at a cost of 27 cents, including the following operating charges: 4.2 gallons fuel oil at 5 cents; lubricating oil at 50 cents (including allowance for renewing oil every 30 days) 2 cents per ton; sinking fund set aside for maintenance 4 cents, making a total of 27 cents per ton.

ATLAS DIESELS are slow speed, heavy duty machines, operating at the same speeds as modern vertical duplex ammonia compressors, and conservatively rated for continuous service at these speeds. The ideal arrangement is therefore an ATLAS DIESEL direct connected to its compressor, with a V-belt driven generator to supply power for the operation of auxiliaries and lighting.

The application of ATLAS DIESELS to ice and refrigeration plants is covered in detail in our "ICE & REFRIGERATION CATALOG," a copy of which will be mailed free to any ice maker who requests it on his business letterhead.

ATLAS IMPERIAL DIESEL ENGINE CO.
OAKLAND, CALIFORNIA, U. S. A.

ATLAS IMPERIAL

DIESEL PROGRESS

REX W. WADMAN, Editor and Publisher

Every Man owes a portion of his time and of his substance to the upbuilding of the profession or industry to which he belongs.
— Theodore Roosevelt

TEDDY had a grand ability of cogently stating his beliefs, an ability given to so few of us. We do, all of us, owe a part of our time and of our substance to the upbuilding of our profession or business. In this connection my hat goes off to Clessie L. Cummins, President of the Cummins Engine Company, who, as this is written, is driving to the Pacific Coast the first Diesel equipped passenger car in this country.

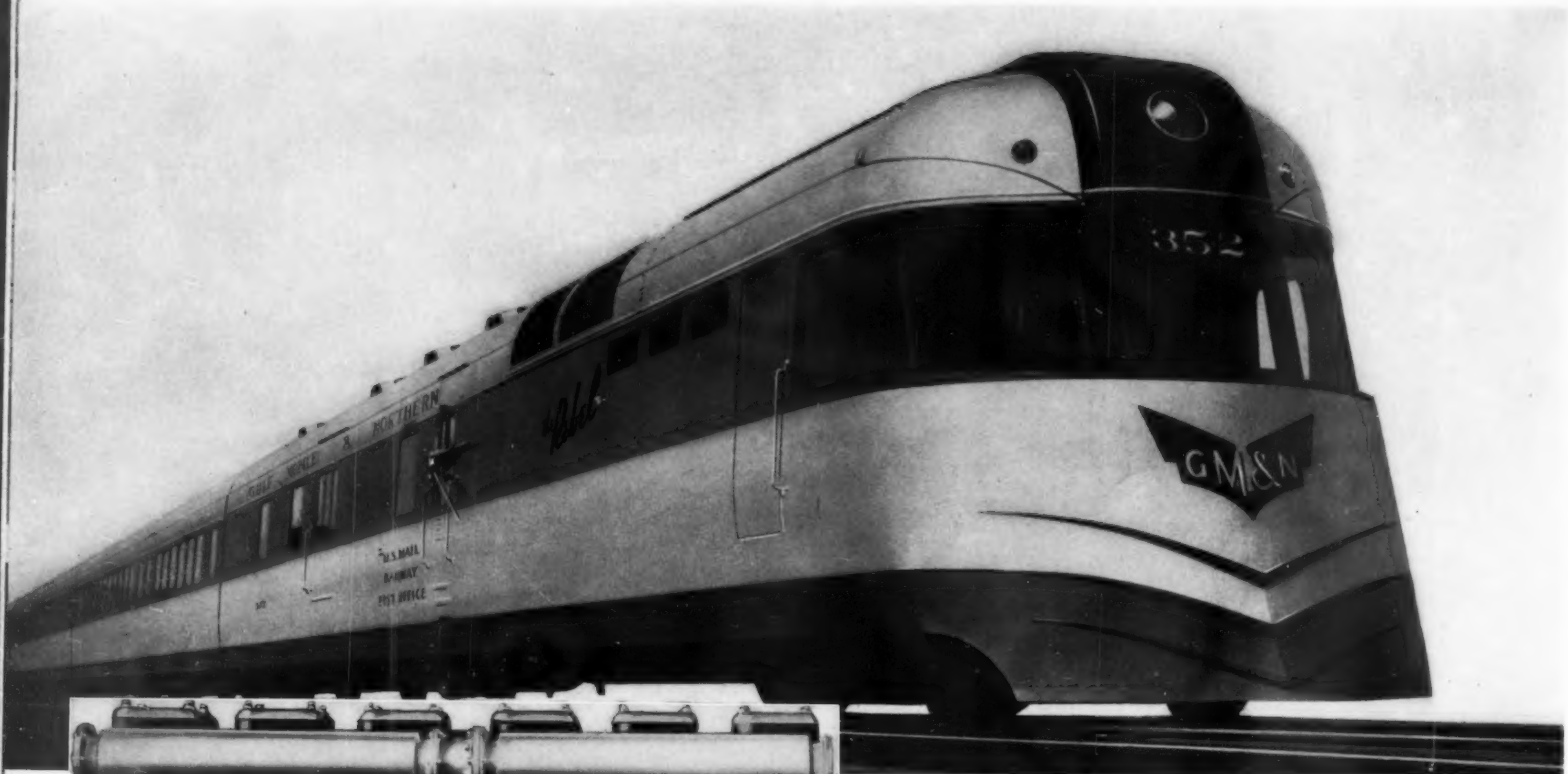
Mr. Cummins is apparently a natural born pioneer. He drove the first Diesel equipped bus across the continent. His company was amongst the first to install Diesels in trucks in this country — commercially. He built and entered in the 1931 Indianapolis Decoration Day Race the first Diesel equipped racing automobile which was the only gasoline or Diesel racing car to finish without a stop of any kind. He took his racing car down to Daytona Beach on two occasions and created world's records for Diesel automobiles, records which still stand.

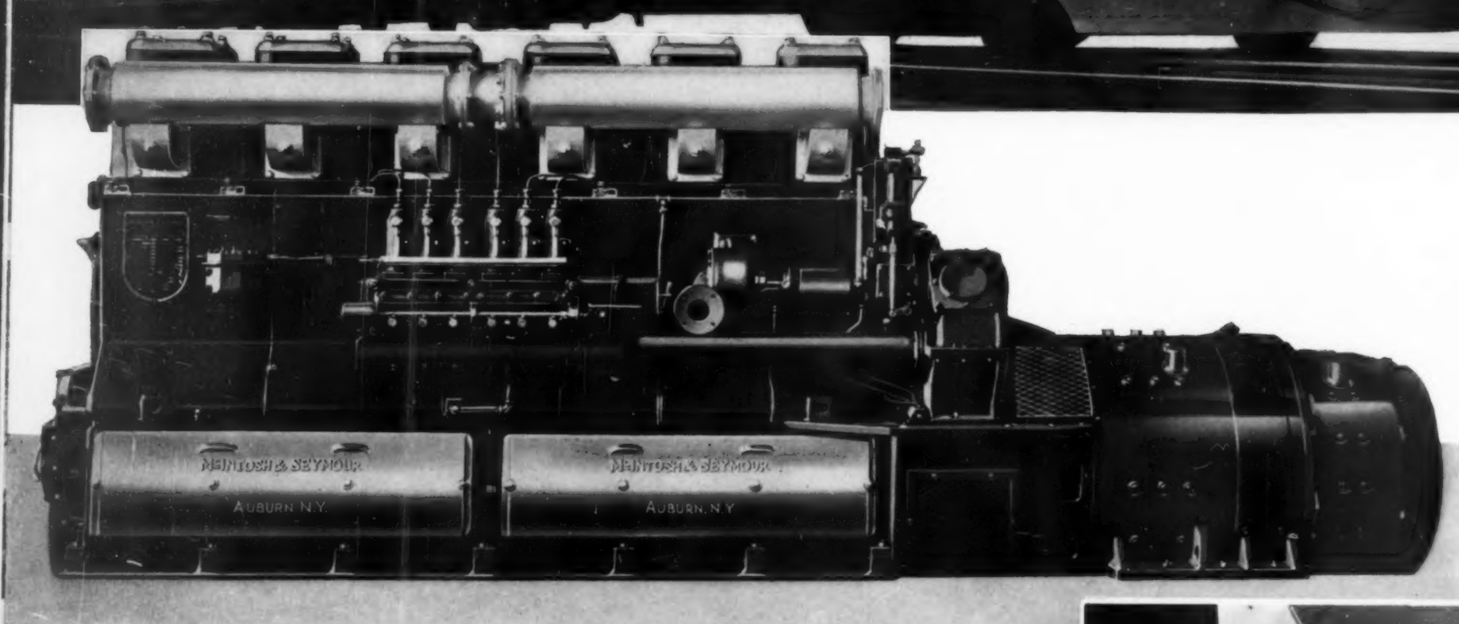
In this new pioneering effort of his, I doubt if Mr. Cummins seriously anticipates the immediate or even near-immediate quantity production of a Diesel passenger car. He has proved, however, that the Diesel engine has been developed to a point where it is smooth enough in operation, light enough in weight and compact enough for passenger car installation — and so my sincere congratulations, are extended to him for his accomplishment, for his foresightedness — for his intestinal fortitude, if I may use the colloquialism. The fact remains he has again contributed something really worth while to the upbuilding of the industry to which he belongs.

ANNOUNCEMENT

A Spanish edition of Diesel Progress will be issued in September, printed throughout in Spanish and distributed to all Latin American countries, Philippine Islands and Spain. This is in addition to our regular September issue. A cordial invitation is extended to our readers to send us names and addresses of possible Diesel engine purchasers in the countries indicated.

Rex W. Wadman





Above — The "Rebel" and its Alco type McIntosh & Seymour Diesel engine rated at 660 hp. at 740 rpm.

Right — Two views of the sleeping section. The berths are individually air-conditioned and partitions afford additional privacy.

THE REBEL

Gulf, Mobile & Northern Rebels at the Old Order of Transportation and Buys Diesel-electric Streamlined Train Which Is Appropriately Named

WITH *Rebels* and *Flying Yankees* invading the railroad field, it may sound to the traveling public as though the Civil War of railroading was about to start. But such is not the case, for, although the names of these new Diesel streamliners are reminiscent of Civil War days, they have been so named for more appropriate reasons.

The *Rebel* is the Gulf, Mobile and Northern's answer to antiquated methods of rail transportation in the South, while the *Flying Yankee* was the first of the new Diesel streamliners installed in the Yankee territory of old New England. To meet the passengers' demands for speed with comfort and safety and the railroads' need for economy of operation, both of these trains are powered with Diesel engines.

The *Rebel* is one of two fully streamlined trains which have been designed and built by the American Car and Foundry Company for the Gulf, Mobile and Northern Railroad. These new Diesel-electric trains will operate between New Orleans and Jackson, Tenn.

The run of 488 miles in each direction, including 39 stops, will be made at night on about a twelve-hour schedule. Because of the heavy traffic conditions between New Orleans and Jackson, Miss., a distance of 186 miles, an extra coach is added on the morning run from Jackson, Miss., to New Orleans and is returned to Jackson on the evening run.

Unlike most Diesel-electric streamline trains, the *Rebel* is not articulated, but is made up of separate coaches having smooth, unbroken lines. Thus these two new trains, consisting of three cars each, can easily be made into a four-car train when traffic conditions demand additional space. Each train will ordinarily consist of a power car in which is mounted a 660 hp. McIntosh & Seymour Alco type Diesel engine directly connected to a Westinghouse generator; a buffet coach with compartments for white and colored passengers and an observation-sleeping car. A seventh coach, with separate compartments for white and colored passengers, can be used interchangeably on the two trains.

The power car is divided into three parts: an engine room, approximately 25 feet long, a 15-foot mail room, and a 30-foot baggage room. The Alco type McIntosh & Seymour Diesel engine operates on the four-cycle principle and has a normal rating of 660 hp. at 740 rpm. and an idling speed of 350 rpm.

The engine weighs 24,500 lbs., or 37.1 lbs. per hp. It has six cylinders enbloc of 12½-inch bore by 13-inch stroke. Made entirely of welded rolled-steel sections, the cylinder block is in one piece, as is also the cylinder base made of the same welded construction. This welded construction has resulted in a reduction of more than 20 lbs. per hp. from the usual weight of engines built for switching service with cast cylinder block and base.

Close-grained cast-iron cylinder liners are fitted in the cylinder block and, like the bearings, may be renewed periodically after an anticipated service of five to ten years. The cylinder heads are separate castings of semi-steel, one for each cylinder, and each head contains two intake and two exhaust valves, as well as the fuel-injection nozzle, all arranged symmetrically. The valve operating gear is entirely enclosed and pressure lubricated.

A heavy crank shaft is mounted in seven 9½ inch by 5½ inch main bearings in the engine base. The aluminum pistons are of the trunk type with cast-iron rings and the connecting rods are steel forgings. The engine base is extended to provide a base to which the generator frame is bolted. Access to the running parts in the base is provided by large detachable covers on both sides of the engine. Fuel is pumped from the 600-gallon fuel-oil reservoir by a small motor-driven pump to the injection-pump unit mounted on the side of the engine. This injection-pump unit contains six individual pumps, one for each cylinder.

A lubricating-oil reservoir is located in the engine base below the floor and all bearings and moving parts are lubricated under pressure by a power-driven oil pump located in the bottom of the base on the front end of the engine.

The Diesel engine drives three Westinghouse electrical generators. The generator assembly, which consists of the main generator, the auxiliary generator and the control generator, weighs 10,520 lbs. The main generator, which is rated 450 kw. at 740 rpm., provides power for propelling the car and is also used for starting the engine. The auxiliary generator, the stator of which is overhung at the rear of the main generator, is rated at 60 kw. and develops power at 130 volts d. c. for the air compressor, radiator fans, air conditioning, generator excitation, lighting, cooking and battery charging throughout the train. The output of the control generator is used for operating the engine

Wide seats and roomy aisles in the coaches.

The comfortable accommodations in the observation lounge.

loading-control apparatus. A fan is mounted on the Diesel-engine flywheel which forces ventilating air through the generator assembly.

The second car of the four-car train, which is the set-out car, is 75 feet long and has two compartments, one seating 47 persons for white passengers and the other 24 for colored passengers. The seats in this car are reversible. The entrance vestibule, in this and the other cars, is at the center. The arrangement is more convenient for passengers and permits the trucks to be placed close to the ends of the car, obtaining better riding qualities. All cars are air-conditioned throughout.

The third car is like the second, except that it has a buffet in the end of the car which carries the white compartment. The buffet is fitted with electric stove and warming oven, cabinets and all necessary supplies for serving meals to passengers. The seats in this car, which is turned with the train, are stationary. The backs are adjustable to the passengers' wishes. The car will seat 62 persons, 24 colored and 38 white.

Probably the most interesting of the trailer cars is the observation sleeping car. In this car the utmost in comfort has been provided. The car has six sleeping sections and a stateroom. The stateroom is provided with an upper and a lower berth extending crosswise of the car. In the daytime the lower berth is a handsome sofa and the upper is folded into the walls. In addition there is a smaller sofa for daytime use.

The sleeping sections are divided by partitions. These partitions are provided with ducts, which operate at night to provide a continuous flow of conditioned air through each berth. A separate circulation system is operated during the day when berths are not made up. Berth lights in uppers and lowers are equipped with special lenses for night reading. Overhead ceiling lights are arranged with three bulbs so that general illumination is possible before passengers retire, yet after retirement only floor illumination is secured and no light shines into the berths.

A large, sunny observation room, seating 18 persons, is at the rear of the car. The room is provided with comfortable arm chairs and sofas. If desired, four people can face each other or play bridge, as portable tables are a part of the train's equipment.

The exterior finish is aluminum with a scarlet band running around the entire train along the window line. An upright searchlight in the head of the train, sweeping the sky as a warning to approaching motorists, heralds the approach of the *Rebel* as it speeds along.

The operation of these new Diesel-electric trains now completes the motorization of all passenger service on the Gulf, Mobile and Northern. As far back as 1924 regular gas motor cars were installed for part of its service and later, in 1930, a Brill constructed gas-electric train was added to its equipment. So the addition of these two new streamlined Diesel powered trains is more of an evolutionary step for Gulf, Mobile and Northern than it is an innovation.

Having been a pioneer in the motorized passenger train field, the purchase of these new trains is the next natural step in the railroad's passenger program. Engineers have fixed top speed at 100 miles an hour, although President I. B. Tigrett has stressed the fact that great speed will not be a factor in their operation. Reductions in the present schedules, he has stated, will be effected more largely through their greater acceleration and deceleration at station stops. Passenger comfort, safety and economy of operation, he added, were the paramount objectives in planning the trains.

WHEN DIESEL MEETS DIESEL

Above — On a highway detour just above California's famed Gaviota Pass on the Pacific Coast highway where construction is in progress to cut down the grade to modern demands. Diesel meets Diesel when a Hercules Diesel Cletrac 80 tractor passes a Cummins Diesel Motor Truck and Trailer of the Pacific Freight Lines. Truck and trailer are hauling steel reinforcing materials for the project. Pacific Freight Lines own 73 Diesel trucks with Cummins engines. Costs over three years and several million miles of freighting show 2.78 cents cut per mile. The tractor and seven other Diesel tractors belong to the Hanrahan Construction Co. of San Francisco. This one had no major overhaul at the end of 4,000 hours. It burns about five gallons of 27 Diesel fuel per hour.

Left — Bekins Van & Storage Company's White truck and trailer equipped with a Cummins Diesel engine. It is leaving Los Angeles for its weekly round trip to San Francisco via the Coast Highway. With comparative figures at 100,000 miles on a change-over from gasoline to Diesel engines, Bekins' head mechanic finds that as far as fuel costs go, a round trip with a Diesel engine costs about $7.50 as compared with $75.00 with gasoline.

Left — Cummins Diesel motored truck spreading oil on Hoover Ranch private roadway in front of ranch house. This and another Diesel motored Mack truck are owned by Oilfields Transport Co., Bakersfield and Taft, California. Tank holds 1,000 gallons of oil.

Left — Golden State Company, Ltd., Diesel motored truck and trailer leaving Oakland, Cal., headquarters for its daily 400-mile run to gather milk and cream in the San Joaquin Valley. This Cummins Diesel is a change-over from the gas engine originally installed in the Indiana truck. Pay load of about 16 tons is usually hauled by this outfit.

INSIDE THE DIESEL

By A. M. ROTHROCK
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS*

JUST why is the Diesel engine forging ahead at such a rapid rate? Why are they found in constantly increasing numbers year by year in industry, in transportation, on the sea and in the air? Why has this comparative newcomer made such strides in America and in Europe during the last few years?

The answer is contained in one word.

Efficiency!

If Dr. Rudolph Diesel, experimenting with his first engine in 1893, could see today European shipyards turning out more Diesel motorships than steamships, German automobile factories producing more Diesel than gasoline trucks and buses, Diesel engined airplanes flying on regular transport lines, and four such engines of 1,000 hp. each selected to furnish motive power for the new German Zeppelin now being completed, he too, would be astonished.

Imagine his surprise coming to this country to find here a factory production of Diesel engines last year capable of generating a total of more than 750,000 hp. and this year probably 1,500,000; Diesel powered streamline trains giving such remarkable performance; and the sudden popular interest in Diesels in the past two years.

The Diesel engine, as we know it today, is, of course, far removed from its ancestors. From a slow, heavy ponderous piece of machinery it has evolved into a fast, light, sleek and thoroughly modern engine. It is the combined results of changes and improvements of many men in several countries. In 1910 McKechnie, an Englishman, showed that the fuel could be injected into the cylinder under its own hydraulic pressure, making possible its development to a high-speed engine. In 1928, Woolson, an American, showed that the Diesel could be built light enough to power airplanes. These steps were epoch making.

What is there about the Diesel engine that makes it differ from its gasoline cousin? To answer this question we must look inside the engine itself and see what actually takes place.

To better understand the processes that take place let us first, however, briefly summarize what happens in the gasoline engine, with which most of us are familiar. As the piston of the gasoline engine starts on its downward stroke a fresh charge of air and fuel is sucked into the cylinder. Air and fuel have been thoroughly mixed in the carburetor and in the intake manifold. When the piston reaches its bottom position the cylinder contains all the ingredients for the explosion — carbon and hydrogen in the fuel and oxygen in the air. To explode the mixture only heat is needed.

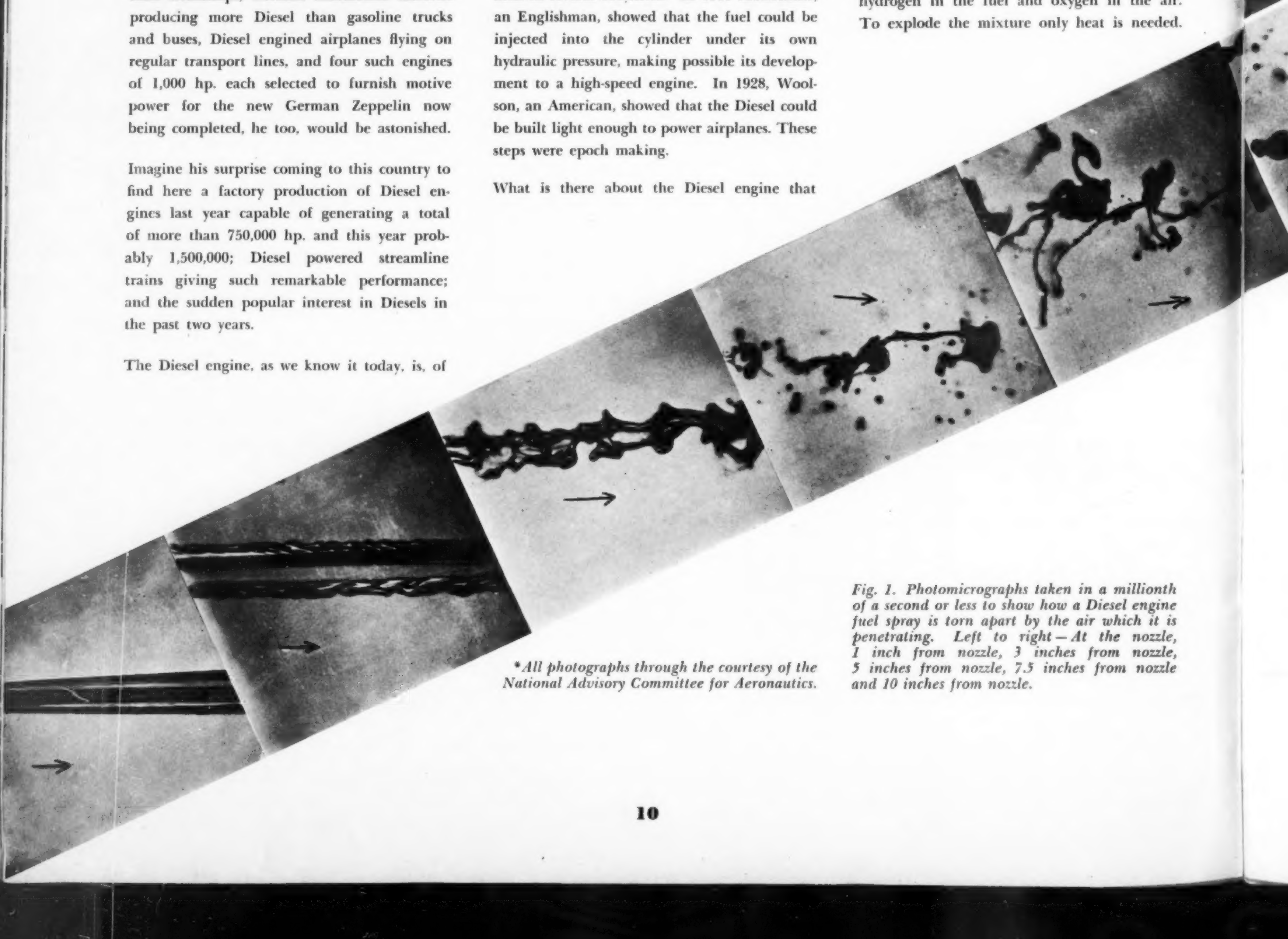
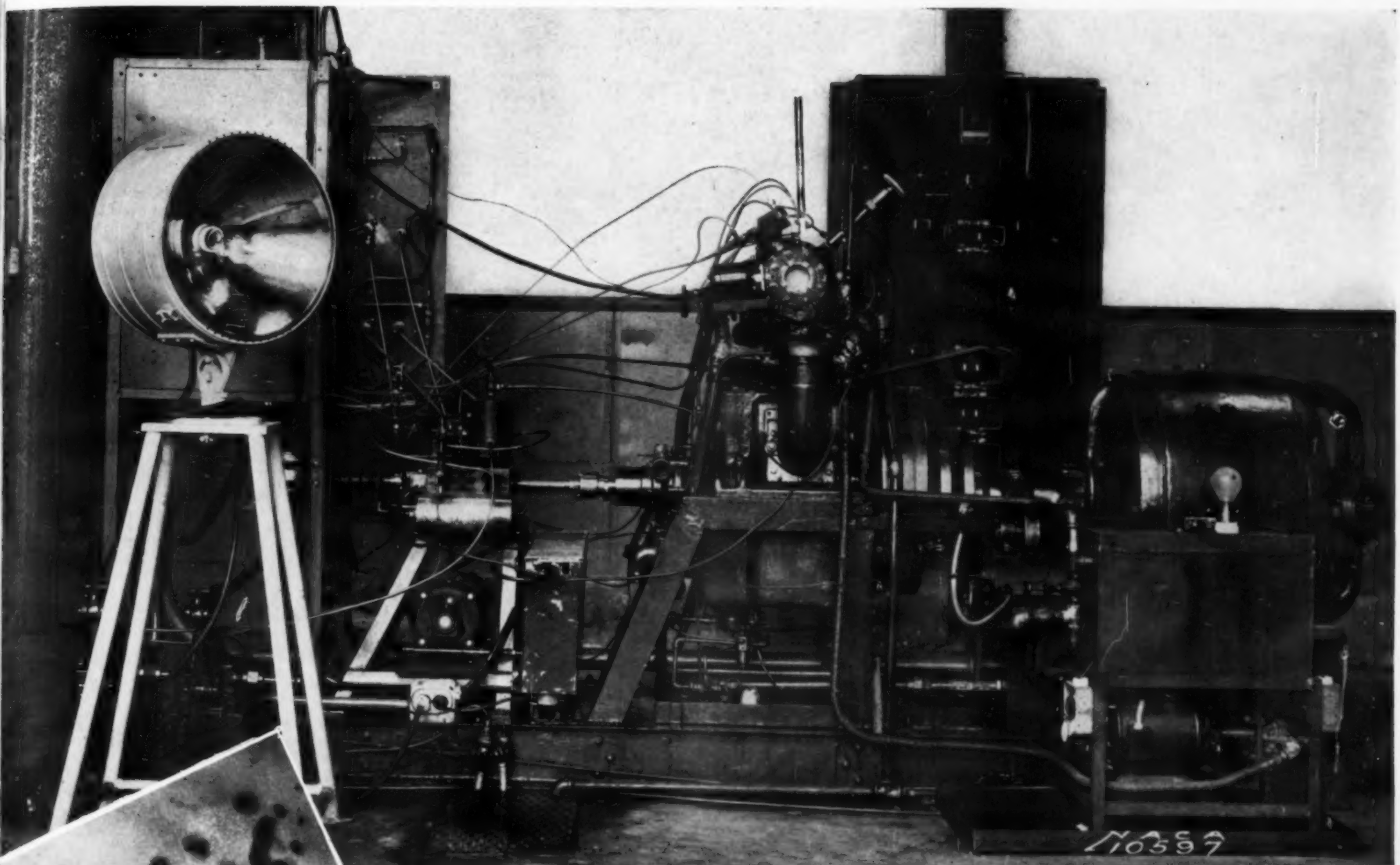
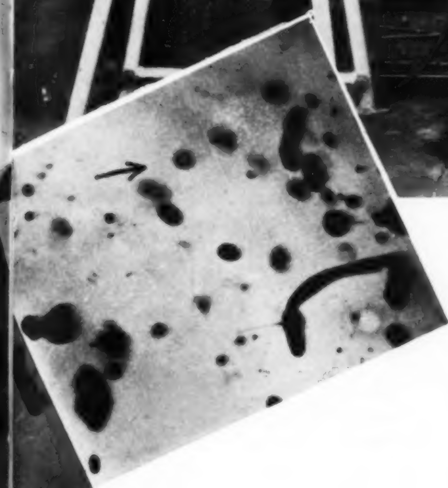


Fig. 1. Photomicrographs taken in a millionth of a second or less to show how a Diesel engine fuel spray is torn apart by the air which it is penetrating. Left to right — At the nozzle, 1 inch from nozzle, 3 inches from nozzle, 5 inches from nozzle, 7.5 inches from nozzle and 10 inches from nozzle.

**All photographs through the courtesy of the National Advisory Committee for Aeronautics.*





Top — Fig. 3. Single cylinder engine with glass windows in the cylinder head developed by the National Advisory Committee for Aeronautics to photograph the injection and combustion of fuel sprays in a high-speed Diesel engine.

Below — Fig. 2. High-speed fuel jet in the process of breaking up into millions of droplets varying in diameter from several thousandths to several ten-thousandths of an inch.

Then the piston starts on its upward stroke, compressing the mixture of air and fuel vapors to about one-sixth of their original volume. In doing so the mixture is heated to 800 degrees Fahrenheit and its pressure reaches 150 pounds a square inch. Still the mixture does not explode. More heat is necessary. This heat is supplied by the electric spark shortly before the piston reaches its uppermost position, igniting the mixture and causing it to burn.

In burning, the flame proceeds across the cylinder in an orderly manner at a velocity of approximately 75 feet a second. The heat produced by the burning increases the pressure to 300 pounds a square inch. The downward push exerted on the piston by this pressure gives the engine its power.

Now in the Diesel engine power is also produced by burning or "exploding" the mixture of air and fuel. But the process is different.

On the downward stroke of the piston the intake valves open and only fresh air is sucked into the cylinder. The fuel is added later. As the piston starts its upward stroke it does not contain any explosive mixture but only air. Instead of compressing this air to one-sixth of its original volume as a gasoline engine does, it compresses it to about one-fifteenth of its original volume. This additional compression causes the air to reach a pressure of 450 pounds a square inch and raises the temperature of the air in the cylinder to 1,500 degrees Fahrenheit.

Into this highly heated and compressed air a charge of fuel is shot at speeds up to 500 feet a second. Because of its tremendous velocity as it rushes through this air, the fine jet of liquid fuel injected under high pressure at the top of the cylinder, is rapidly torn apart into minute droplets varying in diameter

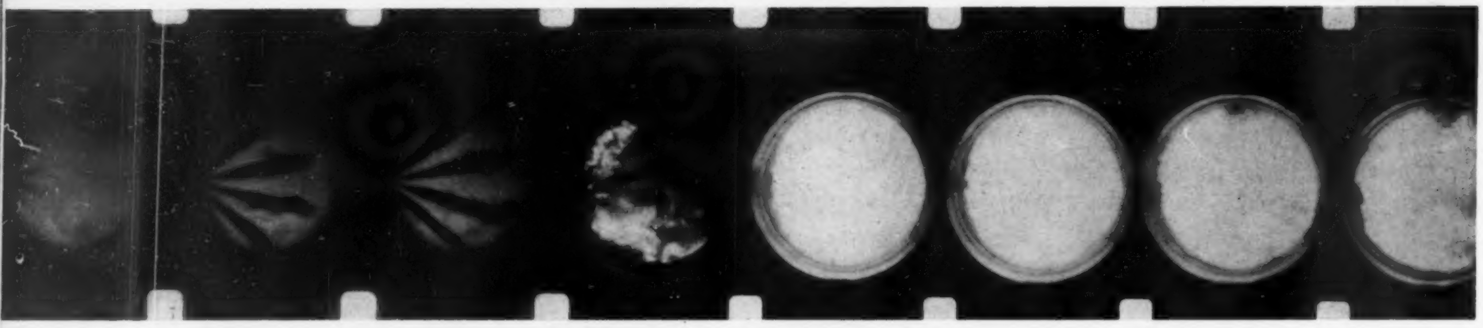


Fig. 4. Motion pictures taken at the rate of 2,500 a second showing the injection and combustion of four fuel sprays in a high-speed Diesel engine. Speed is 1,500 rpm., jacket temperature 150° F. and ideal air-fuel ratio 17.2-1. First picture — Sprays entering the engine cylinder. Fourth picture — Sprays catching fire. Fifth picture — Flame fills the cylinder head. Last picture — Flame starting to die out.

from thousandths to ten-thousandths of an inch. The highly heated air in the cylinder quickly vaporizes the droplets forming a mixture of fuel and air sufficient to ignite of its own accord. No spark plug is necessary. The subsequent explosion increases pressure in the cylinder from 450 pounds a square inch to 800 pounds a square inch, and the piston is forced down on its power stroke.

The chief differences therefore between the two types of engines are: first, in the gasoline engine air and fuel are drawn in together while in the Diesel they are introduced separately; second, the gasoline engine compresses the explosive charge to *one-sixth* its original volume while the Diesel compresses it to *one-fifteenth*. It is this difference between the amounts of compression and subsequent expansion force that makes the Diesel superior in transforming more of its potential energy into useful mechanical work.

Before looking inside the cylinder of the Diesel engine to see just what does happen there let us first turn our attention to observing with more detail how the fuel is forced into the cylinder. How is the fuel shot into the cylinder at speeds of 500 feet a second? On the engine is a small pump which first measures out the quantity of fuel to be injected. As the piston comes up on the compression stroke the pump compresses this charge of liquid fuel in a tube which connects the pump to a small injection valve mounted in the top of the cylinder. The fuel is further compressed until its pressure reaches 1,000 to 20,000 pounds a square inch. In the injection valve are several small holes varying in diameter from a few hundredths to a few thousandths of an inch. The pump is so timed that just before the piston reaches the top of its stroke the liquid fuel is forced through these small holes into the cylinder.

The expansion of the fuel after emerging from the terrifically high pressures in the injection tube into the much lower pressure in the cylinder causes the fuel to reach its high velocity. All this takes place within a very short time interval. The quantity of the fuel shot into the cylinder varies from the size of a pea to the size of a pin head.

The development of the injection pump, a major engineering achievement in itself, represents twenty years of work to bring it to its present high state of perfection.

For a long time it was a matter of conjecture as to *how* the little streams of injected fuel were torn apart inside the cylinder and became mixed with air to form an explosive mixture. Did the air rip the liquid fuel jet into the millions of small droplets or did the jet literally blow itself to pieces because of its inherent instability? Did the ignition take place only at one point and from that point spread the flame throughout the cylinder, or did burning start simultaneously in several places?

Now we can see for ourselves.

A special engine with glass windows in its sides was recently designed and built by the staff of the Langley Memorial Laboratory of the National Advisory Committee for Aeronautics, which at last reveals these processes to the eye by means of ultra-high-speed photographic apparatus. The special type of camera used for photographing bullets in flight was employed. To determine how the sprays break up into the millions of small droplets it was necessary to take photomicrographs of the processes and furthermore to take them in one-millionth of a second or less.

Here we have the results. Figure 1 shows a picture of a fuel jet in the process of disintegration. We see a solid column of liquid issuing from the discharge orifice. As the column travels from the injection nozzle it starts to vibrate forming ruffles and undulations along the edges of the jet. At three inches from the discharge nozzle the ruffles become very marked. The air through which the jet is rushing is tearing it apart. At five inches the spray has broken up into ligaments. These ligaments in turn are broken up into tiny drops a few thousandths of an inch or less in diameter. The photographs shown here were taken at a low jet velocity so that the details of the process could be studied. Figure 2 shows the spray shooting its way through the air at the tremendous velocities it reaches in the cylinder. As it forces its way we see it being torn to pieces.

Now for the ignition. To make photographs that would show the entire process was a real problem. The glass windows 2½ inches in diameter in each side of the cylinder head had to withstand a terrific strain. Figure 3 shows the engine. Between the windows the injection occurs and the explosion takes place. The explosion creates for an instant a furnace of burning fuel which exerts on the windows a force of two tons. It reaches a temperature of 3,500 degrees Fahrenheit. The glass would not stand these conditions if they were not all over in nine or ten thousandths of a second. Motion pictures of the injection and combustion were taken in this short time interval at the rate of 2,500 a second. While the conventional motion picture camera takes pictures at the rate of 16 a second, this special apparatus made it possible to speed up our vision 150 times. In figure 4 are some more of the filmed action. The interval between each photograph or "frame" is four ten-thousandths of a second. Each photograph was taken in one-third that time or about one ten-thousandth of a second.

What do the pictures show? In the first frame we see the round silhouette formed by the

. . . . *And now please turn to page 33*

DEPENDABLE DIESELS

DIESEL CRUSHING PLANT

Top — One of the Caterpillar Diesel units that operates screening and crushing plants on the Metropolitan Aqueduct project twelve miles south of Banning, Cal.

BITING THE DIRT

Upper right — A 250 hp. Fairbanks, Morse Diesel engine is the power behind this 6-yard bucket as it bites its way through the dirt of the Colorado River Aqueduct near Eagle Mountain, Cal.

BELLY UP!

Lower right — A Cletrac 80 tractor going up grade, while working on the nation's biggest construction job at the Colorado River Aqueduct. It is powered with a Hercules Diesel engine.

DIESELS REDUCE POWER COSTS OVER SEVENTY PER CENT

WHAT is the "ideal" Diesel installation? Like the hypothetical "average man" there is no such animal, but if a survey of ice manufacturing plants were made right now it is doubtful where a better Diesel installation could be found than in the plant of W. B. Chaffee of East Providence, R. I.

From every standpoint, appearance, performance, quietness and economy of operation, and all-round satisfaction, it comes very close to being the ideal Diesel installation. No wonder that W. B. Chaffee is quite proud of it. Any ice manufacturer would be.

The W. B. Chaffee ice plant was built in 1928. Up to June, 1934, its ice-making machinery was operated by purchased current, furnished at the rate of 1.24 cents a kilowatt hour, by the local power company. The power cost per ton of ice manufactured averaged about 68 cents. There are few businesses in which power forms such a large proportion of production costs as does the ice manufacturing business. Like many other ice plant owners have done in recent years, W. B. Chaffee switched to Diesels and found the solution to that problem.

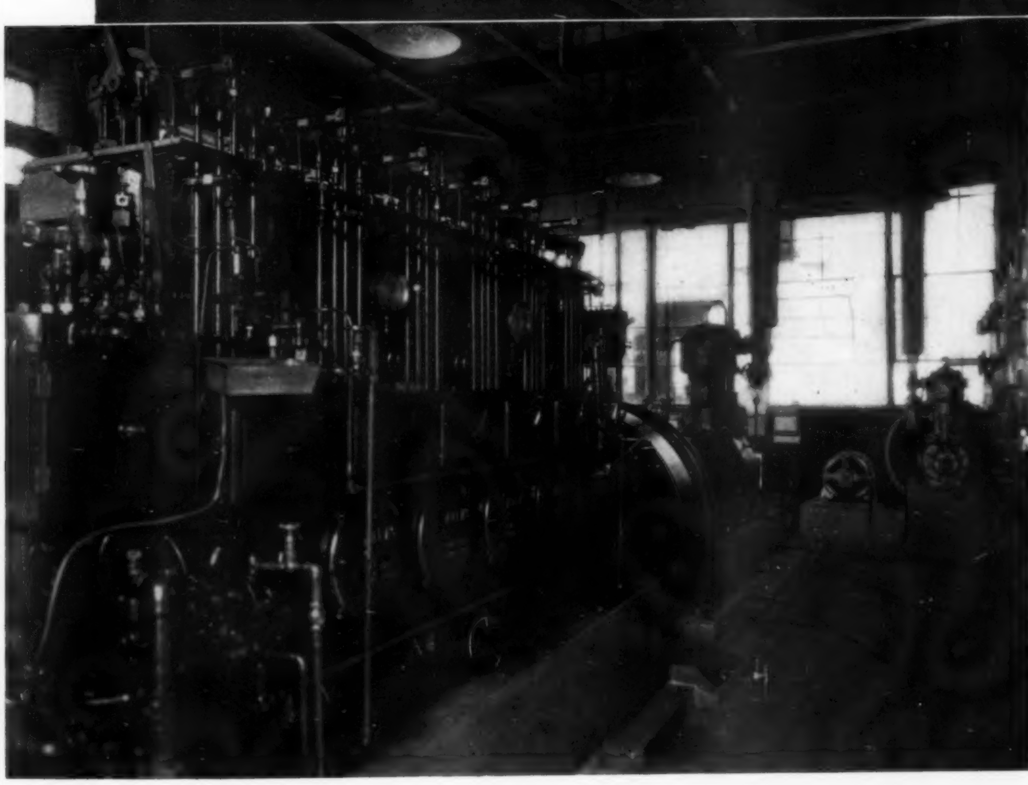
Ice manufacturers who depend upon outside sources for their power needs are aware of many drawbacks under such a system. Such plants are particularly vulnerable to interruptions of transmission in severe thunderstorms during hot spells when the demand for ice is usually at a peak. Two years ago power went off five different times in the Chaffee plant one night during a thunderstorm which descended on Providence late one summer evening. As soon as one break in the transmission lines was repaired another followed just as the ice-making machinery was ready to go into operation again, with the result of a total loss in production that night. Where there should have been a production of thirty tons to keep ahead of demand, all manufacturing was at a standstill. Interruptions such as these had raised havoc with production in the past, costing the plant on an average of $1,000 a year according to W. B. Chaffee and Clarence Frey, chief engineer of the plant. One day last month when a black-hooded storm bore down the valley and burst in all its electrical fury over Providence and its surrounding cities, causing another break in the transmission lines, Chaffee and Frey sat in their chairs smoking their pipes and winked at each other. They could afford to. While street lights went off and other plants were darkened, theirs ran serenely on – with Diesel engines generating power as usual.

Fuel and lubricating oil and a small quantity of chemical products used in ice-making are practically the only commodities the Chaffee plant has to buy. Water is pumped by electric motors from two Artesian wells and the Diesels generate all current needed for lights and electrically driven machinery.

The Chaffee plant is known as an Arctic Pownall type. The installation is a York plant with a Pownall system freezing tank for which power is supplied by two six-cylinder, four-cycle, solid injection Atlas Imperial Diesel engines each rated to develop 180 hp. at 300 rpm. They burn Number 4 fuel oil and have been in operation since June, 1934. To date not a penny has been spent for repairs of any kind.

Each engine is direct connected to a 50 kw. 62.5 kva. 550 volt generator and a 10 x 10 York ammonia compressor. The current supplied by these two direct connected generators also serves to operate during periods of peak production a 6½ x 6½ York ammonia compressor driven by a 30 hp. Westinghouse motor and a 4 x 4 York ammonia compressor driven by a 7½ hp. Westinghouse motor.

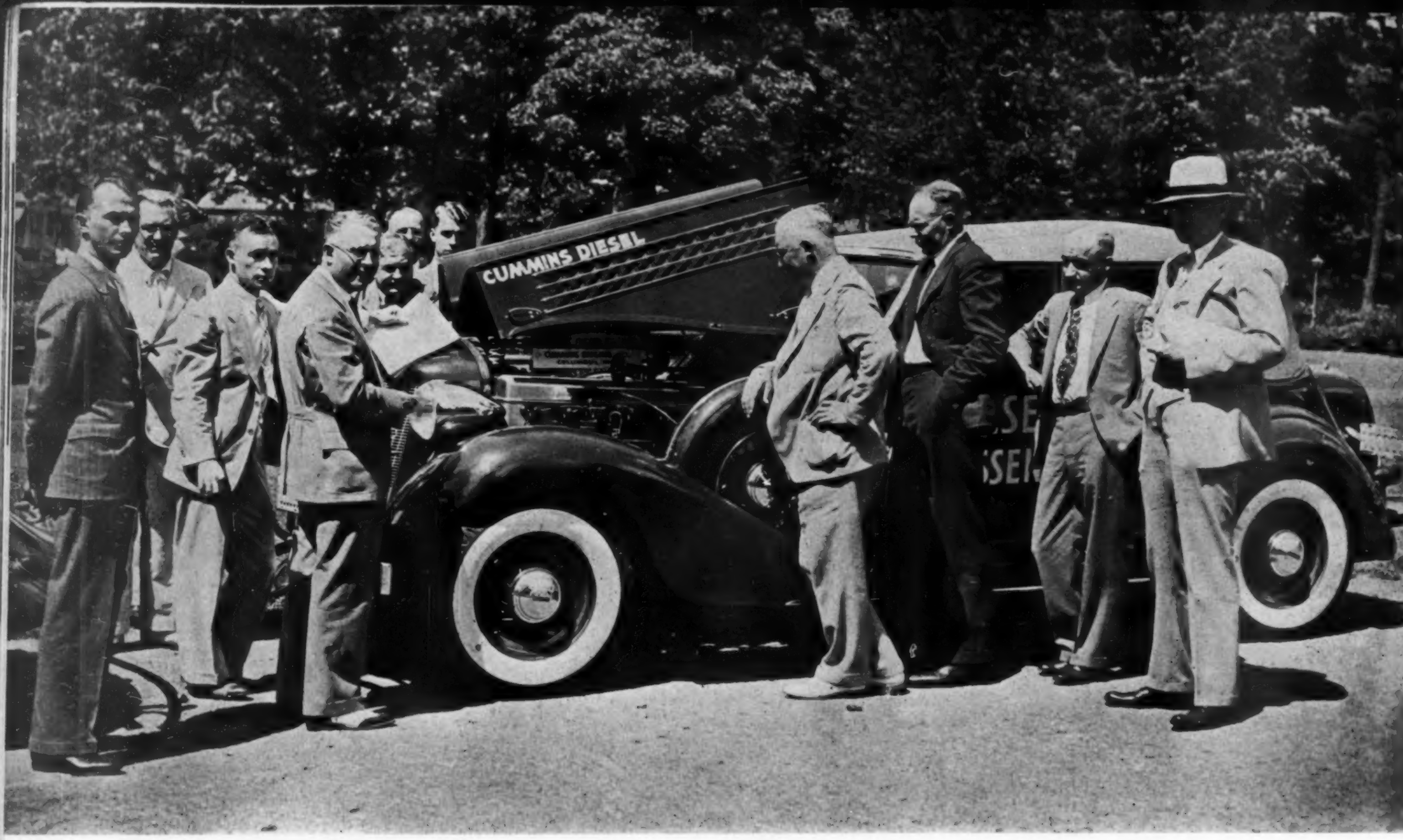
Chaffee Ice Plant, East Providence, R. I.



Two Atlas Imperial Diesel engines each rated at 180 hp. at 300 rpm. installed in the Chaffee Ice Plant.

Left — Close-up of one of the engines taken before plant was entirely completed.

The current thus generated also furnishes power to individual electric motors which operate: (1) two deep-well turbine pumps of 5 hp. and 10 hp. respectively pumping water from two Artesian wells 423 feet and 606 feet at the rate of 250 gallons a minute (2) a brine agitator using 7½ hp. (3) a 15 hp. and a 10 hp. condenser pump for a large spray cooling pond on the roof (4) an air blower for agitating water in the freezing cans using 7½ hp. (5) a 5 hp. air compressor furnishing compressed air to operate an overhead . . . . *And now please turn to page 35*



COAST-TO-COAST ECONOMY RUN

Auburn Stock Model Phaeton Sedan Equipped with Cummins Diesel Engine Averaging 40.2 Miles per Gallon of Fuel Oil

OFF on a coast-to-coast test trip, an Auburn car with a Cummins Diesel engine left the City Hall at New York recently and made the 496 miles to White Sulphur Springs, W. Va., at a total cost of 74 cents for fuel, plus a tax of 38 cents. This is averaging 40.2 miles per gallon on the 12.3 gallons of fuel oil used.

It is the first Diesel powered passenger car to be placed in operation in America. Operating at its present rate of economy, it should be able to make the 3,000-mile trip to the coast at a fuel cost of less than $8.00.

Mr. C. L. Cummins, president of the Cummins Engine Company, is the owner and driver of the car and is accompanied on the trip by Fred Duesenberg, a nephew of the late automobile builder of that name. They stopped first at White Sulphur Springs to attend the convention of the Society of Automotive Engineers. From there the motorists are heading west and will proceed leisurely across the country, taking about ten days for the trip.

The automotive engineers in attendance at the Society's convention were deeply interested in the Diesel engine itself and its application as a source of automotive power for passenger cars. The engine is a six-cylinder Cummins Diesel developing 85 hp. at 2,200 rpm. It has a 3¾-inch bore and 5-inch stroke and its total weight including accessories is 900 lbs.

An interesting installation of a Nugent filter has been made on the lubricating oil line, insuring clean oil to the bearings. Another interesting departure from normal passenger car practice is the installation of an Alnor pyrometer on the dash, with a thermo-couple in the exhaust line, thereby enabling the driver to know at all times the exhaust temperature and to start looking for trouble if that temperature varies widely.

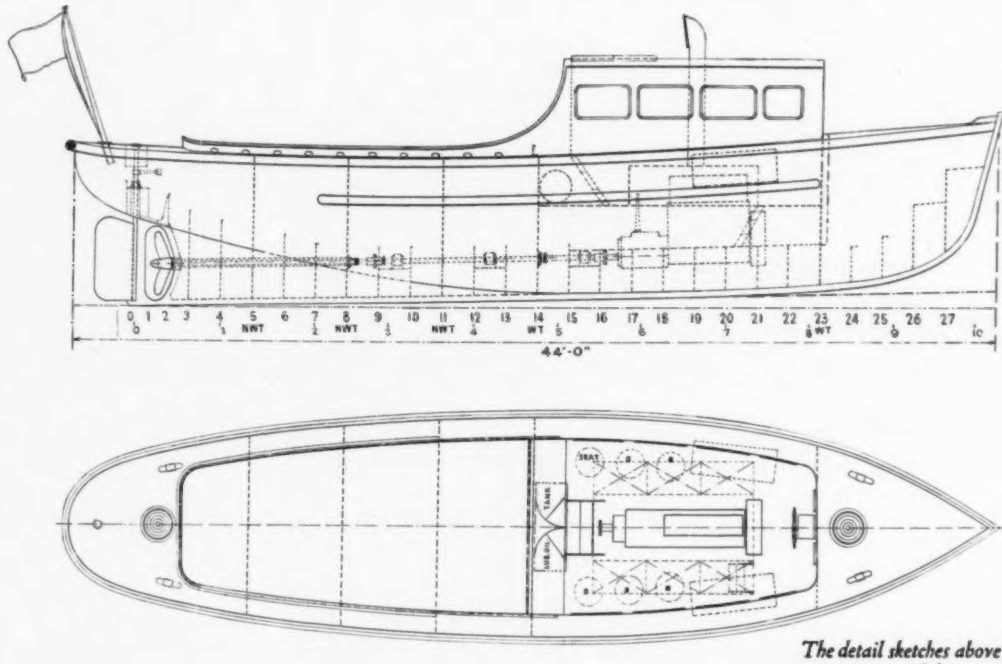
A report from Chicago, dated June 27, stated Mr. Cummins had arrived there in the Diesel passenger car; that he had traveled 1,200 miles up to that time at a fuel cost of $2.21 for the 1,200 miles; that he expected to make the entire trip to the Pacific Coast for a fuel cost not to exceed $8.00. The car has developed a top speed of 90 miles per hour and they have averaged 50 miles per hour on the trip to date.

C. L. Cummins at the wheel of the first Diesel powered passenger car.

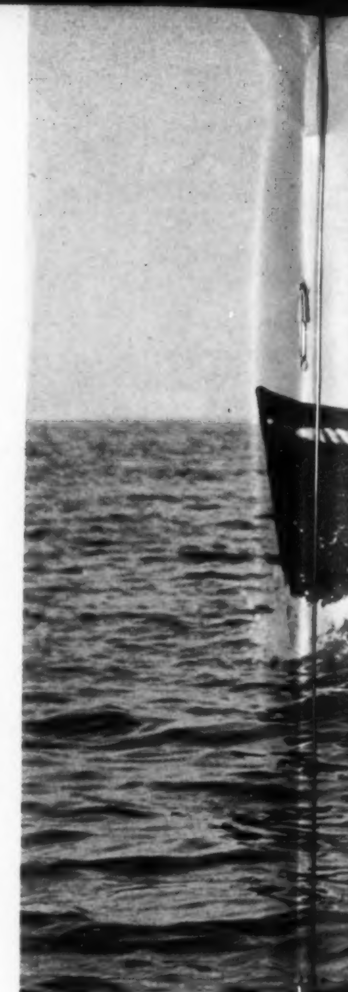
Below — The instrument board showing Alnor pyrometer installation to right of steering wheel.

The engine in this car is, in practical detail, the same unit which has been installed and successfully operated in hundreds of trucks and buses in this country; it is a tried and proven design.

A deep significance attaches to this successful application of a Diesel engine to passenger car service. The test run of this car across the continent does not immediately presage the availability of Diesel powered automobiles to the automobile buying public. It does, however, demonstrate in no uncertain manner the fact that the Diesel engine has been developed to a point where it is smooth enough in operation, light enough in weight and compact enough to be installed in a stock passenger car. This Cummins-Auburn Diesel car is the first of its kind; pointing the way, further developing the art of Diesel engine design and application — definitely an experiment, as yet, but a tremendously interesting experiment which may lead to vast changes in our conception of automobile economy, and which may also lead to a vast upheaval in the distribution of automotive fuel. It remains to be seen whether the American car buyer is sufficiently interested in fuel economy to demand and pay the price for a Diesel equipped automobile — if he is, then that demand will be satisfied.



The detail sketches above show the general arrangement of these new launches. Their dimensions are as follows: Length over-all, 44 feet; Length, waterline, 40 feet; beam, 10 feet; draft, 4 feet, 3 inches



Showing installation of six-cylinder Winton-Diesel engine. Cabin design provides for roomy accommodations and excellent visibility

W

Symbol of Economy and Dependability

Rolling along with a 22-ton payload.

WHEN THE SOUTHERN PACIFIC LEAVES THE RAILS IT USES DIESELS!

AT Mecca, Cal., transportation history is being made by the Southern Pacific Railroad in the handling of freight.

Four Fageol trucks powered by Waukesha Silver Comet Diesel engines, and equipped with special bodies and trailers are handling cement in bulk from the railway siding for the Southern Pacific at this point. The trucks, working around the clock 24 hours per day, are taking the cement in 22-ton payloads from the railroad to the construction camps along the Colorado River Aqueduct, distances of 26 and 56 miles at the present time. When three more similar units are added, the haul may be lengthened to take care of the demand.

Extending their rail delivery by truck was done at Boulder Dam and other construction projects as well, but the bulk handling of cement required development of truck bodies and trailers that are new. The cement is delivered in box cars and unloaded by a giant vacuum sweeper that discharges the cement into the closed receivers, and from these receivers, the trucks are loaded, by gravity, through the hatches on the roof of the special trailer body. Three trucks with two trailers each will move a carload of cement.

On the Colorado River Aqueduct delivery, the trucks negotiate a stiff grade from below sea level for nearly thirty miles through Shavers Canyon to the crest of the desert over which the Aqueduct is being built. Enough cement to lay a modern highway 24 feet wide from coast to coast is being used in the building of this 241-mile water main. It is most important that a regular schedule of delivery be maintained, and on this construction project, Diesel operated trucks are giving both reliable and economical service in the haulage of large tonnages of bulk cement.

They are dispatched from an office at the siding under orders from the dispatcher the same as trains. The truck makes the round trip to The Three Companies' Camp 45 miles away in six hours with its 22-ton payload and, working on a 24-hour schedule, makes four round trips daily. Remarkable fuel economy is reported as a result of the use of Diesel engines.

Fageol truck equipped with a Waukesha Diesel unloading cement at the Colorado River Aqueduct.

THE CRUISE OF THE VAGABONDIA

14,000 Miles Through the South Seas in an 856-Ton Diesel Yacht With a Fuel Consumption of 6.28 Gallons Per Mile and Lubricating Oil Consumption of Only 0.03 Gallon Per Mile

WHEN Mr. W. L. Mellon's Diesel yacht, *Vagabondia,* returned from a 14,000-mile cruise of the South Sea islands, there were smiles of satisfaction on the faces of her Captain, George Stoehr, and her Chief Engineer, H. Helmedach. Not only had the owner and his party enjoyed a carefree and enjoyable cruise of two and a half months, but, due to the reliability of the yacht's Diesel engines, not a minute had been lost because of engine trouble, so both Captain and Engineer were well satisfied with the yacht's performance during the long and sometimes dangerous trip.

The *Vagabondia* is not a new boat, having been built at Krupp Shipyards at Kiel in 1928. Today the yacht has more than 100,000 miles of cruising on her log, and her main Diesel engines have turned over more than 110,000,000 revolutions.

The power plant of the *Vagabondia,* which is located approximately amidship, consists of two 800 bhp. 4-cycle solid injection type Krupp Diesels, operating at 260 rpm. The auxiliaries consist of two Krupp generators of 50 kw. for lighting and electric power driven by two 100 hp., 4-cycle Krupp Diesels, and one 12 hp. Diesel engine for driving the air compressors.

The *Vagabondia* has a gross tonnage of 856 tons, is 224 feet long, with a beam of 34 feet and a draft of 12½ feet. With the power installed, a maximum speed of 14 knots an hour is readily secured, and for extended voyages a sea speed in excess of 12 knots can be easily maintained.

Enough fuel and lubricating oil can be stored in her tanks to provide for a cruise of 10,000 miles. An average daily run of 320 miles consumes about 1,800 gallons of Gulf 28-30 fuel oil.

Probably the most remarkable part of the whole cruise as far as Diesel engine economy is concerned is the fact that only 0.03 gallon of lubricating oil was consumed per mile. Mr. Helmedach, the Chief Engineer, attributes this fine performance to two important facts. First, only a very fine grade lubricating oil is used on the *Vagabondia,* namely, Gulf Pride 75 of 40-50 viscosity and secondly, this oil is thoroughly cleaned by means of De Laval purifiers after every ten hours running time.

During the six years that these purifiers have been installed on the yacht, the lubricating oil has never been changed, but by means of these De Laval centrifuges a total amount of 2,200 pounds of carbon has been removed from the oil during this six-year period.

The saving in lubricating oil expense has easily paid for the cost of the oil purifying equipment. That the oil itself is still in excellent condition is attested by the fact that the wear on the crank and wrist pin bearings was found to be less than .001 since the time they were originally installed.

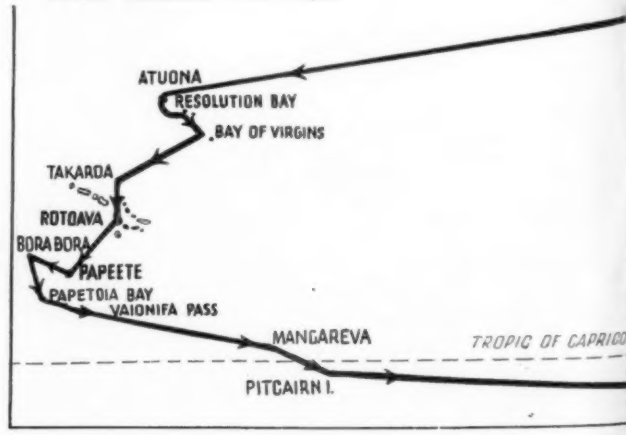
The important facts that Diesel engine users may learn from the successful cruise of the *Vagabondia* are the advisability of using only a good grade lubricating oil in their Diesels and the necessity of keeping their lubricating oil clean and free from carbon. By adopting this policy, lubricating oil costs may be kept down to a minimum.

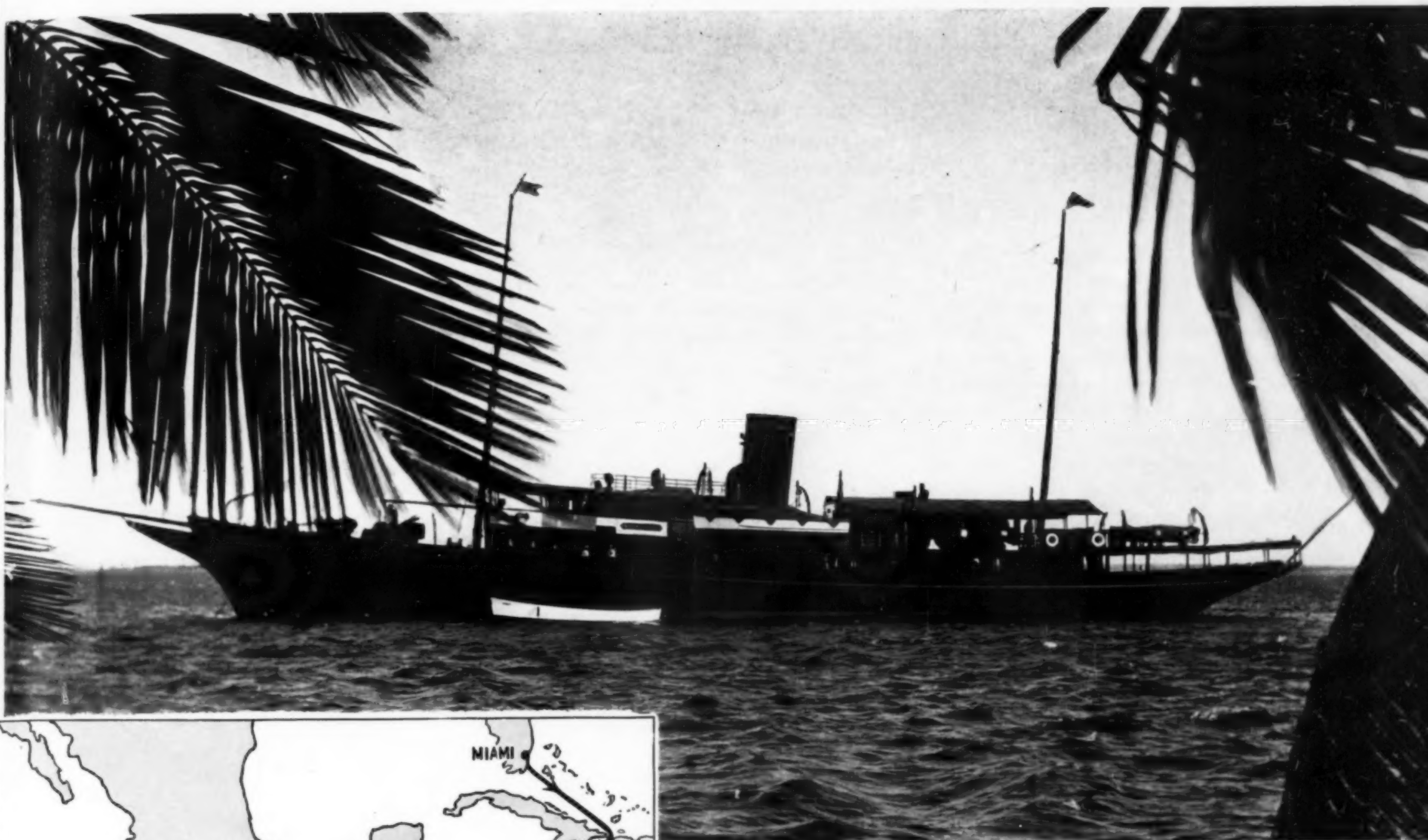
Starting from Miami on February 4, the cruise lasted until April 18 when the *Vagabondia* once more cast anchor at Miami. The total trip covered 13,988 miles and the longest stay at any one port was only four days at Papeete on Tahiti. The longest stretch at sea was between Wreck Bay and Atuona (Marquesas) when nearly ten days were required to cover the 3,026 miles. The complete itinerary of the cruise is given below.

VAGABONDIA CRUISE 1935

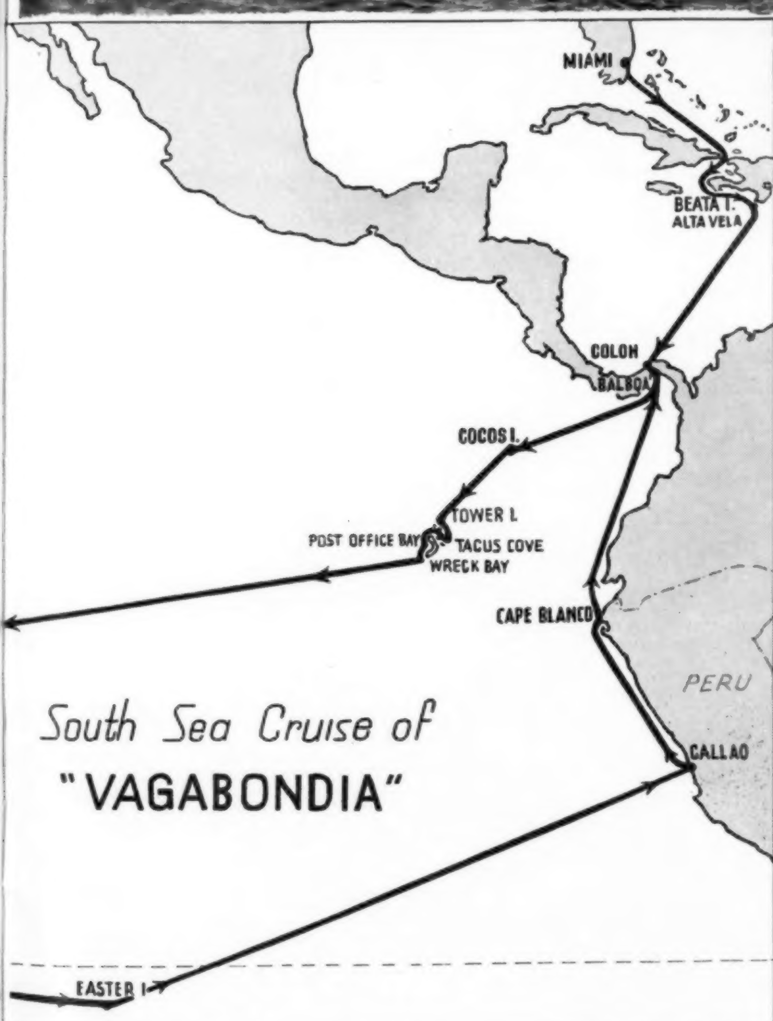
From	To	Miles	Arrived	Sailed	Average Speed
Miami	Beata Island	791	Feb. 4	Feb. 4	12.5
Beata Island	Alta Vela	8	Feb. 4	Feb. 4	
Alta Vela	Colon, C. Z.	697	Feb. 7	Feb. 7	12.9
Colon	Balboa	36	Feb. 7	Feb. 7	
Balboa	Cocos Island	544	Feb. 10	Feb. 11	12.6
Cocos	Tower Island	365	Feb. 13	Feb. 13	10.9
Tower Island	Tagus Cove	132	Feb. 15	Feb. 15	13.5
Tagus Cove	Post Office Bay	123	Feb. 15	Feb. 15	9.8
Post Office Bay	Wreck Bay	57	Feb. 15	Feb. 16	10.8
Wreck Bay	Atuona (Marquesas)	3026	Feb. 26	Feb. 27	12.9
Atuona	Resolution Bay	13	Feb. 27	Mar. 1	
Resolution Bay	Bay of Virgins	42	Mar. 1	Mar. 1	11.3
Bay of Virgins	Takaroa (Tuamotus)	445	Mar. 3	Mar. 3	12.4
Takaroa	Rotoava (Fakarava)	118	Mar. 4	Mar. 5	7.7
Rotoava	Papeete (Tahiti)	245	Mar. 6	Mar. 10	12.8
Papeete	Bora Bora	150	Mar. 10	Mar. 13	12.3
Bora Bora	Papetoia Bay	130	Mar. 14	Mar. 14	11.6
Papetoia Bay	Vaionifa Pass	54	Mar. 14	Mar. 17	12
Vaionifa Pass	Mangareva	868	Mar. 20	Mar. 21	11.9
Mangareva	Pitcairn	288	Mar. 22	Mar. 22	11.9
Pitcairn	Easter Island	1139	Mar. 26	Mar. 28	12.3
Easter Island	Callao (Peru)	2045	Apr. 4	Apr. 6	12.36
Callao	Cape Blanco (Peru)	553	Apr. 8	Apr. 8	13.09
Cape Blanco	Balboa	806	Apr. 11	Apr. 12	12.47
Balboa	Colon	36	Apr. 12	Apr. 12	
Colon	Miami	1277	Apr. 16	Apr. 18	13.2

TOTAL MILEAGE 13,988





The "Vagabondia" in Southern waters.



ENGINE REPORT
MIAMI — TAHITI — MIAMI

February 1, 1935 to April 16, 1935	*Yacht "Vagabondia"*
Total distance in nautical miles	14,000
Running hours, starboard main engine (Maneuvering time included)	1,110
Running hours, port main engine (Maneuvering time included)	1,100
Revolutions of starboard main engine	16,074,160
Revolutions of port main engine	16,002,750
Fuel oil consumption of main engines, auxiliary engines and galley stove	88,000 gals.
Lubricating oil consumption of main and auxiliary engines	420 gals.
Running hours of starboard auxiliary engine	533 hrs.
Running hours of port auxiliary engine	852 hrs.
Running hours of ice machine	1,216 hrs.
Charging batteries	47,000 amps.
Fresh water consumption	58,500 gals.
Dist. drinking water	400 gals.

6.28 gallons fuel oil per mile
0.03 gallon lub. oil per mile
Average speed 12.66 miles, maneuvering included.
Condition of engines is very good.

H. Helmedach, Chief Engineer

MAYNARD, MASS.

After Two Years' Experience With a Diesel Pumping Unit Finds It the Answer to a Low Cost Town Water System

By J. W. REYNOLDS

WHEN the Town of Maynard, Mass., faced the necessity of modernizing its outdated pumping station in 1932 it found itself confronted with a domestic triangle. Should it keep to steam, go over to electric power, or install a Diesel? Which? Mistakes in such a situation are apt to prove both unsatisfactory and costly to the municipalities that commit them.

To begin with, its steam-operated pumping equipment had been furnishing the town with water since 1889 and in 1932 the Waterworks Department's power plant equipment consisted of a Blake direct-acting duplex steam pump of one million gallons a day capacity and a Laidlaw crank-and-flywheel, Meyer gear, condensing pumping engine with a capacity of one and one-half million gallons a day. The former unit was being used only as a standby.

The average rate of pumping was 800 gallons a minute for 10 hours a day against a total dynamic head of 240 feet. The fuel cost, using this system, was $13.80 a million gallons. In the Town of Maynard the water is taken from a large ground suction reservoir right outside the station and lifted 240 feet to a ground storage reservoir about 400 yards distant. The average yearly quantity pumped with the crank-and-flywheel pumping engine in 1931 and 1932 was 104,720,000 gallons.

First to bid on the project was the electric power company. Their bid for an electrically driven plant complete, comprising two automatic pumps, each with a capacity of 285 gallons a minute, was $5,000, while the cost of a Diesel operated plant, they pointed out, would be $17,000.

Only one of the pumps would need to be operated continuously, they stated, adding that this small pump capacity would keep the motor size and consequent power demand down to a minimum operating figure. They also proposed eliminating the station attendant, but, on the other hand, they would include in their estimate an annual charge for supervision.

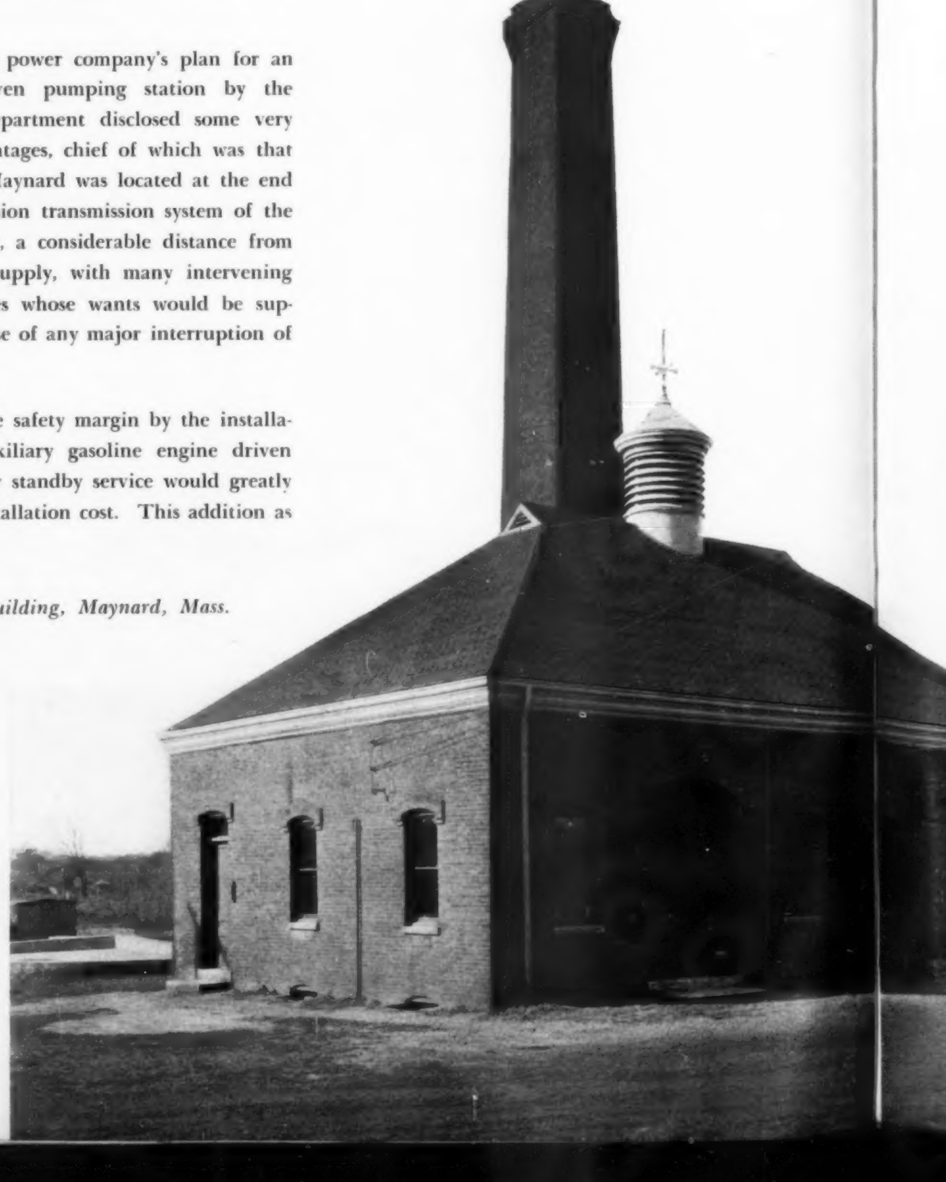
In submitting to the Town of Maynard comparative estimates of operating costs for both electrical and Diesel plants, which included attendance or supervision, fuel versus electric energy, lubrication, repairs, supplies, interest, depreciation and insurance, the utility company computed the annual total operating cost of an electrical plant at $3,664 and that of a comparative Diesel plant at $4,464.

With these figures in their possession, the Waterworks Department turned their attention back to steam. The first cost of installing a new pumping engine and replacing the two boilers then in use was found to be $15,000. Yearly operating cost, including attendance during pumping hours, was found to be still higher – $5,031. Obviously a new steam plant was out, because no better efficiency could be obtained than with their present old equipment.

Analysis of the power company's plan for an electrically driven pumping station by the Waterworks Department disclosed some very serious disadvantages, chief of which was that the Town of Maynard was located at the end of the high-tension transmission system of the power company, a considerable distance from the source of supply, with many intervening towns and cities whose wants would be supplied first in case of any major interruption of service.

To augment the safety margin by the installation of an auxiliary gasoline engine driven pump to supply standby service would greatly increase the installation cost. This addition as proposed by the power company would increase also the annual total costs for fixed charges. Furthermore, the small total capacity of 570 gallons for the two units was inadequate for the consumer demand when it would be necessary to pump direct to the mains when cleaning the reservoir or in event of an emergency. But the most important flaw of all, after the Waterworks Department had figured the entire proposal out, was the high energy cost per million gallons pumped – $25.40. Compare this to what they were paying to pump their water with steam – $13.80.

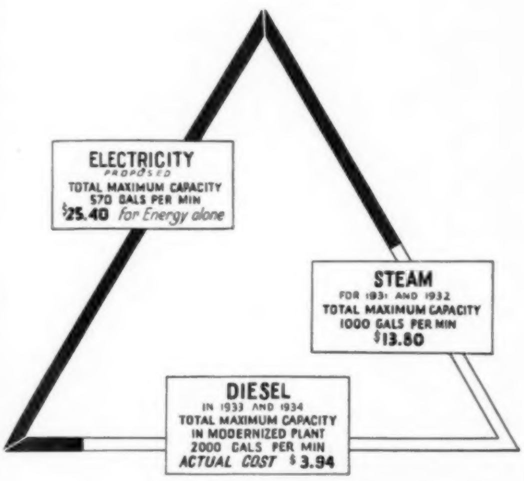
After lengthy consideration the Town of Maynard decided to install a Diesel operated plant. For its main engine they selected a three-cylinder, four-cycle, $8\frac{1}{2} \times 12$ inch me-



Waterworks Building, Maynard, Mass.

chanical injection Winton Diesel rated at 78 bhp. at 400 rpm. with a gasoline engine standby, each unit having a normal operating capacity of 800 gallons a minute with maximum pumping efficiency at this speed, but capable of delivering 1,000 gallons a minute continuously if required.

The result was two separate and independent units, giving the station a total maximum capacity of 2,000 gallons a minute. Each engine is connected with a two-stage centrifugal pump operating at 1365 rpm., the gasoline unit direct connected, the Diesel unit driven through a single reduction herringbone gear speed increaser with a ratio of 3.52 to 1. The pumps are duplicates and interchangeable.



Now comes the interesting part of the story.

How close the power company came to estimating the cost of the Diesel installation and computing the cost of its yearly operation may be gleaned from these figures just released by Maynard's Waterworks Department.

Instead of costing $17,000 to install, as the power company said, the total investment, including the main Diesel engine, and the gasoline standby unit, together with a new heating boiler with an oil burner using the same fuel as the Diesel, amounted to only $12,000 – a difference of $5,000.

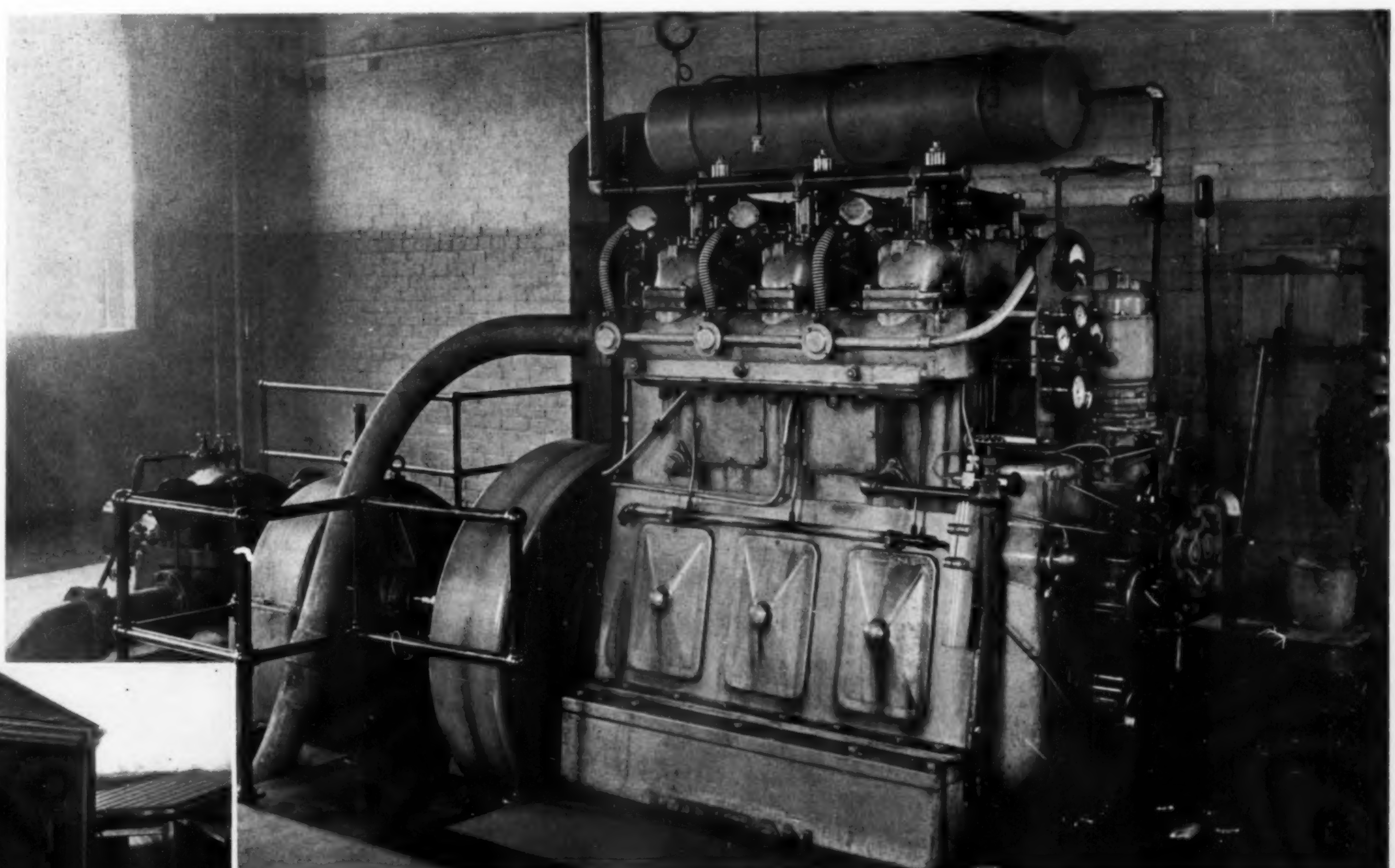
Instead of costing $4,464 a year to operate the Diesel plant, as the power company predicted, the cost was only $3,255.87 – a difference of more than $1,200 a year. Included in the Diesel costs are the same fixed charges proposed by the power company. They include a full-time station attendant, not included in the proposed electrically operated station. Since installation the Diesel engine has never had an enforced shutdown and its gasoline standby has never had to be pressed into service.

Operating seven hours a day, the Diesel unit has pumped in the 24-month period from which the figures are quoted 229,000,552 gallons of water with a fuel consumption of 78.5 gallons of fuel for each million gallons of water pumped and using only 0.83 gallon of lubricating oil per million gallons.

Using fuel costing 4½ cents a gallon and lubricating oil at 50 cents a gallon, the total cost per million gallons pumped is but $3.94. The total cost of repairs to the Diesel unit in all that period is but $4.20, covering one set of cylinder head gaskets in December, 1933.

People today in the Town of Maynard have a never-failing supply of town water in their homes. The pressure measures 45 pounds even in the highest elevated house. The plant attendant shows visitors about the pumping room and can spend the rest of his time repairing water meters. The Waterworks Department saves the town money. This is just a typical instance of how Diesels solve the cost problems of water pumping in many places.

Winton Diesel of 78 bhp. at 400 rpm. operating pumping unit capable of delivering 1,000 gallons a minute.



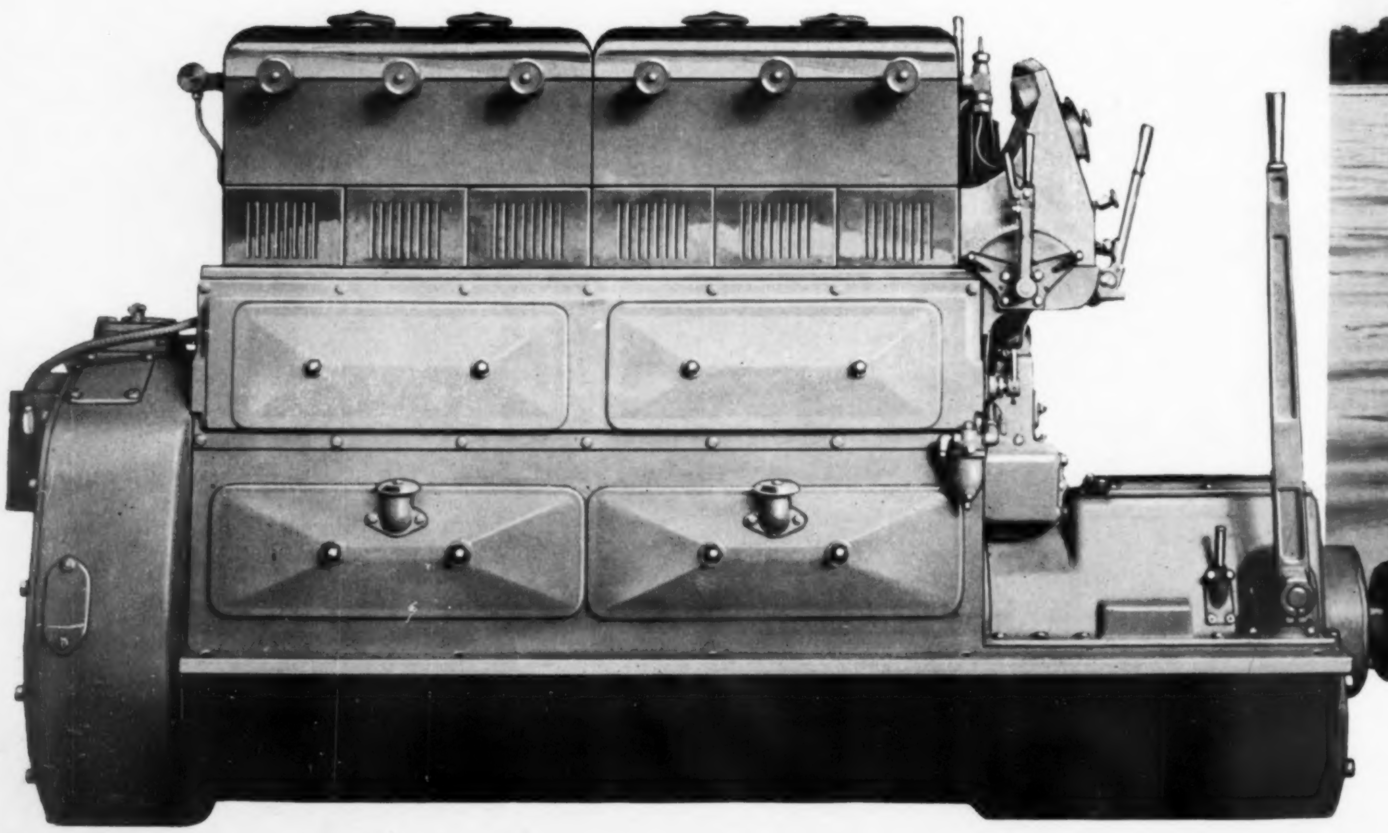
THE FIRE CHIEF, HIS HORSE AND DIESEL

ED WYNN has been loyal to his famous horse these many years, but when it comes to horsepower for his attractive yacht *Chief,* he places his reliance on Diesel engines.

The yacht was built by the Consolidated Shipbuilding Corporation and features luxurious accommodations and ample speed and comfort for the discriminating yachtsman. Accommodations include a large combination dining room and lounge, roomy after deck and cockpit, two double staterooms with connecting baths and ample quarters for the crew. The *Chief* is exquisitely finished and furnished with luxurious drapes and upholsteries.

The boat has recently been repowered with two six-cylinder Winton Diesel engines developing 120 hp. each at 1,200 rpm. Even Ed Wynn admits that this is more horsepower than his renowned horse can develop. He is well satisfied with his selection of Diesel engines to power his new yacht, and looks forward to a summer of care-free cruising.

Below — One of the Winton Diesels installed on Ed Wynn's yacht.



Ed Wynn looking for his famous horse.

Below — The "Chief" has an overall length of 81 feet, with 14 feet 6-inch beam and 4 feet draft.

YES, THE ICE BUSINESS IS GOOD IN PAWTUCKET

Diesels Furnish Power for Everything Except Delivery Trucks at Plant of Citizens Ice Company

By FRANK M. PRENDERGAST

If you are one of those who have assumed that mechanical refrigerators have sounded the death knell of the ice business in this country de-bunk yourself of the idea right now.

The truth is, the ice business is very much alive today, especially for the companies who have kept abreast of recent progress in that industry, as witnessed by the fact that there are about 8,000 ice manufacturing plants in the United States at present. Of these, a large proportion use Diesels in the process to generate their electrical requirements to the extent of approximately 110,000 horsepower.

Our per capita consumption of ice has increased 400 per cent in the last twenty years. Three-quarters of it is made artificially. Even north of the fortieth parallel, brine tanks and ammonia compressors are replacing lakeside ice houses and four-footed horse power. A considerable share of the increase in the domestic consumption of ice during the past five years has been due to the introduction of the new type air-conditioned ice refrigerators, smart, scientifically designed units that maintain constant cold, proper humidity, eliminate food odors. There is also a new device which, when placed on a level cake of ice, will turn out crystal-clear ice cubes in five minutes. These modern methods of merchandising and manufacturing economies made easier with Diesels are three of the factors which helped to push the annual output last season to more than 70,000,000 tons.

The Citizens Ice Company of Pawtucket, R. I., which supplies ice to more than half the homes and stores in that busy city, is one of the ice manufacturers who believes that the ice industry will continue to hold its place in the refrigerating field and is proving it every year now with a healthy balance sheet.

Its plant, built in 1929, has a production of 60 tons of ice a day. Two Fairbanks-Morse Diesel engines, a three-cylinder 180 horsepower and a two-cylinder 120 horsepower, supply power to two Frick ammonia compressors, and also operate generators that furnish current for every electrical use.

For the sake of economy in operation during non-peak periods as well as increased assurance of continued operation of the two 10 x 10 Frick compressors one of these units is direct connected to the 180 horsepower Diesel and the other to the 120 horsepower Diesel. In each case a generator is belt connected to the flywheel. In the first instance the capacity is $37\frac{1}{2}$ kva. and in the second 56 kva. By thus providing two complete units either one may be operated without the necessity of running the other since ample current is supplied in either case. When the load demands both are run in unison.

The Citizens Ice Company, according to William T. Ross, chief engineer of the plant and one of the owners, figures that it costs between 36 cents and 42 cents to manufacture a ton of ice, depending upon volume and weather conditions, averaging from six to seven gallons of fuel consumed. When the plant was first installed it was estimated that the cost of purchased electric current for making ice in the quantity required would amount to approximately 2.1 cents a kilowatt hour, or 70 cents a ton to make ice. Diesels make it for almost half.

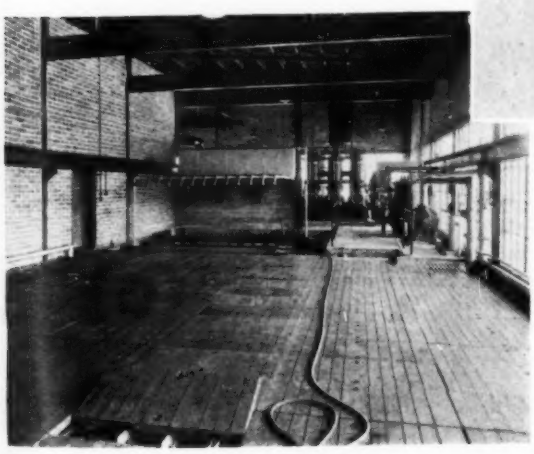
In addition to furnishing power to operate the two large ammonia compressors, the Diesels generate current that operates three water pumps with a capacity of 500 gallons per minute, a three-ton overhead traveling crane in the tank room, two conveyors, a scoring machine, a stacking machine, two agitators that circulate the brine, an air blower to aerate the water as it is frozen to ice, and all the electric lights. Water from the city mains used for drinking purposes is used in making the ice, while cooling water is taken from an adjoining lake.

During the six years the Citizens Ice Company's Diesel plant has been operating there has not been a single major breakdown — this in spite of the fact that in hot weather both engines run 24 hours a day at full load. Only one replacement job has been undertaken in

Above — The storage room which has a capacity of 1,000 tons.

Above — The engine room. At the left is the three-cylinder 180 hp. Fairbanks-Morse Diesel and at the right in the foreground is the two-cylinder 120 hp. Fairbanks-Morse Diesel. Each drives an independent generator belt connected to the flywheel.

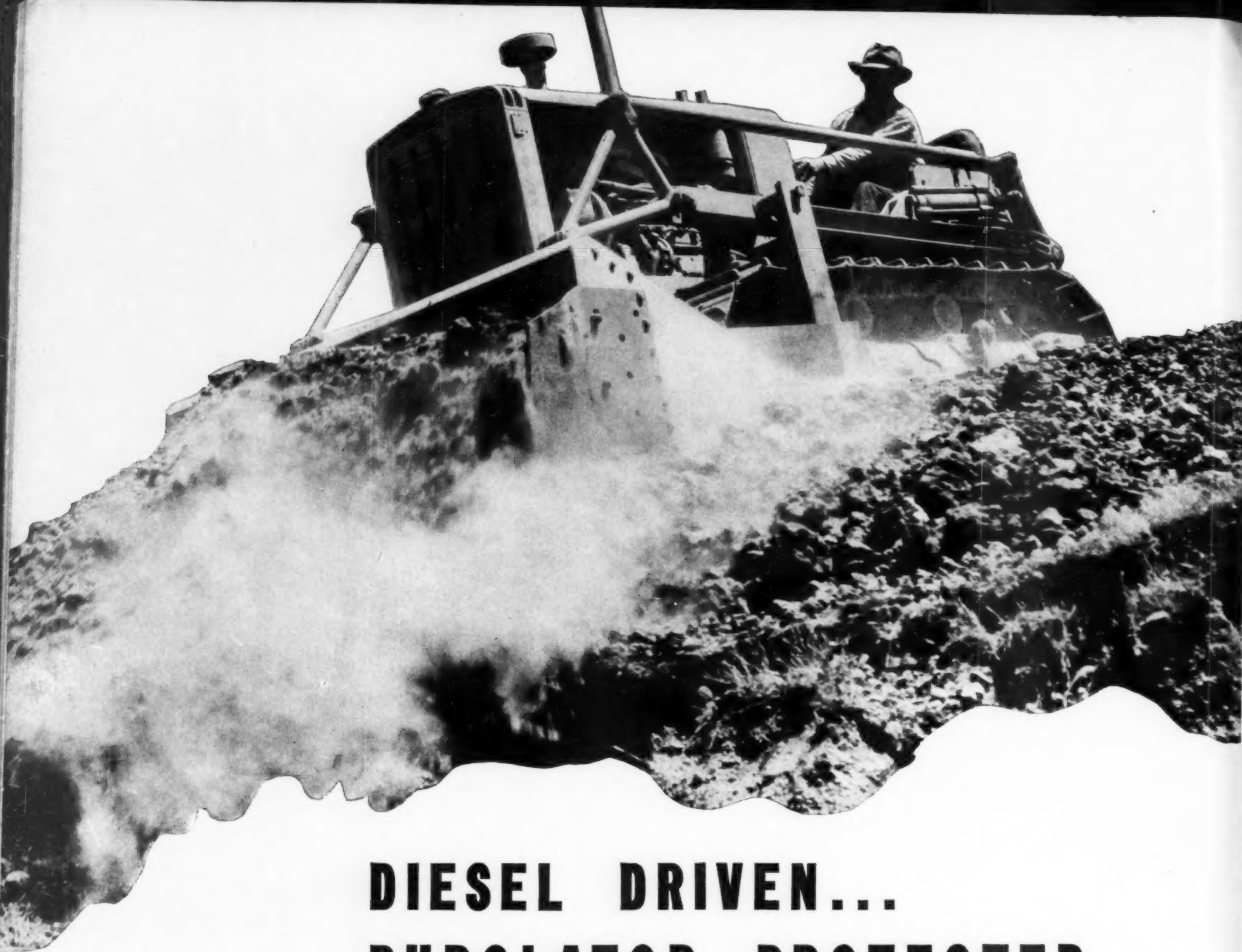
Below — The tank room which can freeze 864 320-pound cakes of ice every 48 hours.



that period, but this was not an emergency job. Due to using an inferior grade of oil, resulting in scored cylinders, three new cylinders were put in last spring in the 180 horsepower unit, the Fairbanks-Morse Company giving the ice company a new set of rebored cylinders in place of the original cylinders, charging them only for the cost of reboring.

Only five men are required to run the ice plant — one engineer and two operators working in three eight-hour shifts, and two storage room men. The company operates ten delivery trucks in Pawtucket and sells its surplus ice to outside dealers.

"The electric power company makes the rates for our competitors," says William T. Ross, "but with our Diesel plant we're independent of them and can make our own."



DIESEL DRIVEN... PUROLATOR PROTECTED

A clean, effective supply of lube and fuel oil . . . maintained, day after day and week after week has been a real factor in the success of the Diesel type of engine.

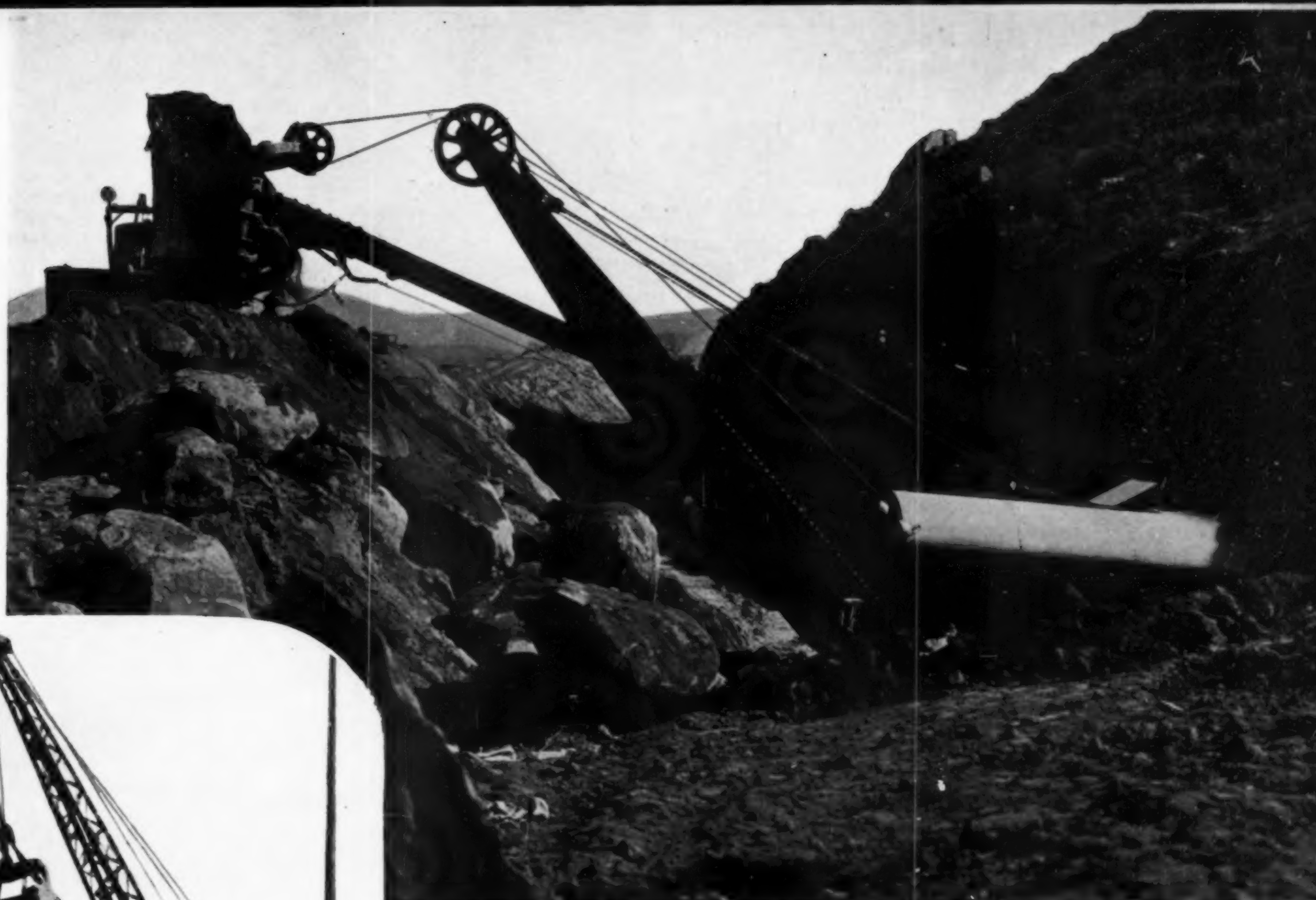
The Purolator Oil Filter has made a big contribution to the economical use of Diesel power. It has caught and held the dirt and grit that scores engine parts . . . has more than doubled the time between overhauls . . . and has kept the fuel supply even and constant and active.

There is a Purolator for every type of Diesel Engine, and each of them has been developed as the result of experienced and intelligently directed research. We solicit your inquiries for any type of Filter that you have in mind.

Motor Improvements, Inc., Newark, N. J. makers of

PUROLATOR

THE OIL FILTER



WAUKESHA PASSES TO CATERPILLAR!

Above — No, it's not a football play, but a Diesel cost-cutting, heavy construction job on the Griffith Company sector of the Los Angeles Aqueduct. A Waukesha Hessellman oil engine powers the Lima Shovel and a Caterpillar 75 Diesel bulldozes the dirt down to grade on the outer bank. On the nearly 200 miles of heavy construction at the Aqueduct, Diesel powered equipment has shown big fuel savings. This is one reason why the public is getting such projects at a much lower cost than would have been possible three years ago before the Diesel was ready for such jobs.

DINKEY DIESEL LOCOMOTIVE

Left — At the gravel plant of the Kaiser Paving Company, Livermore Valley, Cal., two dinkey Plymouth locomotives, powered with Atlas Imperial Diesels, shuttle the cars between plant and siding where a Diesel-powered Brown hoist unloads the cars with a $1\frac{1}{2}$-yard clamshell bucket.

OPERATING A DRAGLINE

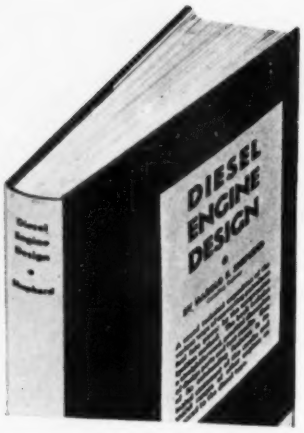
Left — The Utah Construction Company is operating this Atlas Imperial Diesel-powered dragline on a tough stretch of the \$246,000,000 Aqueduct that is to lead the waters of the Colorado River to the industries, and homes of Los Angeles, and surrounding cities. It swings a 1-yard shovel and burns $2\frac{1}{2}$ gallons of 27 fuel per hour.

BETTER THAN TWO GAS OUTFITS

Left — A Buda Diesel engine powers this Koehring 401 dragline on the stretch of Los Angeles Aqueduct being built by Spicer, Robinson, West Company. Bucket $1\frac{1}{2}$ yards. Burns 3 gallons of 24 fuel per hour, according to the operators, and "is better than our two gas outfits."

DIESELS ARE ALWAYS ON THE JOB

The only book in the English language which treats completely the design of all parts of the fuel injection apparatus and combustion chambers in Diesel engines—



DIESEL ENGINE DESIGN

By **HAROLD F. SHEPHERD**

Consulting Engineer, Member American Society of Mechanical Engineers.

227 Pages, 6x9, $3.50

TABLE OF CONTENTS

"DIESEL ENGINE DESIGN" will be indispensable to the engineer who needs a sound technical exposition of the various ways of converting petroleum fuel into power by the compression ignition method. Useful alike to builders, purchasers, and users of Diesel engines, it is not a mere recapitulation of the list of existing models, but presents a straightforward, practical discussion of design parts and test results. One of its outstanding features is its logical statement of the merits and useful ranges of other engines as opposed to the Diesel type.

This new book deals specifically with such subjects as combustion, the influence of the combustion-chamber walls, the fuel nozzle and pump, governing, cylinder heads, valves and valvegear, the injection of gaseous fuel, bearings and lubrication, pistons and piston rings, two- and four-cycle engines, inertia, the flywheel, and all other important factors in the design of Diesel engines. The Diesel engineer's objective is not so much to seek out the best fuels, but rather so to develop his product that it will burn a somewhat broad range of those refinery products which are in least demand for other purposes. To this end the studies on combustion-chamber gas and wall temperatures in this book are exceptionally valuable in connection with the developments which will inevitably result from more general practice of fuel testing.

The author, H. F. Shepherd, is an authority on the design and operation of Diesel engines. He has for many years been active in their development, and is the inventor of numerous special features and improvements well known to engineers in this field.

DIESEL ENGINES, INC., ***Book Dept.,*** **2 West 45th St., New York, N. Y.**

Enclosed please find $3.50 for one copy of the book, "Diesel Engine Design"

NAME ____

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INSIDE THE DIESEL

. . . . *Continued from page 12* . . . .

outline of the glass windows. Close to the left hand side we see four small jets of fuel starting to penerate the dense, highly heated air in the cylinder. In the next frame the four sprays have travelled nearly across the cylinder.

In the third they have gone all the way across the cylinder. Still there is no flame visible. Suddenly, within the next four ten-thousandths of a second, the spray bursts into flame. We see the fire surrounding three of the jets. The fourth has not as yet started to burn. The flame then spreads rapidly so that in the next frame it has filled the entire cylinder. In the last two frames the flame has begun to die out around the cylinder edges. The whole action has taken place in three-thousandths of a second. In that time the liquid fuel was forced into the engine cylinder, partially vaporized, then ignited and burned. It proves, if we repeat the tests, that the sprays penetrate the dense air in the cylinder before catching fire and that the flame starts in several places and then spreads to all parts of the cylinder.

In the actual operation of a Diesel engine this injection and explosion of fuel is taking place anywhere from 300 times a minute on the large slow-speed engines to 2,000 times a minute on the high-speed engines. Each explosion must be an exact duplicate of the last explosion or the engine will not run evenly. They must not take place too fast or the engine will knock. They must not take place too slowly or there will be a loss in power.

Picture then for yourself, a highly refined and reliable mechanism measuring minute quantities of liquid fuel ranging from several thousandths of a pound down to several hundred-thousandths, compressing it to pressures of 1,000 to 20,000 pounds a square inch, shooting this fuel through tiny holes each a hundredth of an inch in diameter, speeding it up to 500 feet a second, breaking it up into millions of small droplets, compressing a charge of air to 450 pounds a square inch, heating this air to 1,500 degrees, mixing it with the liquid drops of fuel, vaporizing this mixture, burning it in four to five thousandths of a second and repeating this process hundreds of times a minute for hundreds of hours! That is the modern Diesel engine.

**The opinions offered in this article are those of the author and not of the National Advisory Committee for Aeronautics.*

DIESELS REDUCE POWER COSTS OVER SEVENTY PER CENT

. . . . *Continued from page 15* . . . .

can hoist in the tank room (6) a motor-driven belt conveyor to take ice from the tank room to the storage room (7) a 5 hp. scoring machine and (8) a 2 hp. stacking machine.

The engine room addition completed last June to house the new Diesel installations is a model of cleanliness and efficiency. Airy and well lighted with large steel frame windows on three sides, it is constructed of pressed face brick inside and out. The floor is all green cement tile with the two engines and their generators resting on a nine-foot deep foundation of solid cement, all resting on two-inch insulation cork. There as practically a complete freedom from vibration.

All piping to the engines has been brought through pipe trenches in the floor. There are no overhead pipes to either engine or compressor with the exception of the ammonia suction and discharge lines which through necessity had to be installed overhead.

All pipes for fuel oil, starting air, and cooling water are of extra heavy copper and brass tubing with long radius bends installed by a skilled coppersmith with neatness and precision. There are no threaded joints in any of these lines. All joints including connections to valves are neatly sweated. All metal surfaces are brightly polished and floors and walls are as clean as a Dutch kitchen.

Undoubtedly one of the most important features of the installation is the exhaust disposal of the Diesel engines. From either within or without the building the exhaust is scarcely audible. Silencing of the exhausts has been accomplished by leading pipes from the exhaust manifolds down to an underground chamber directly outside the engine room. Four-inch pipe is used under the floor, six-inch to the chamber and eight-inch from chamber to top of chimney. The exhaust chamber or pit is built of cement and is ten feet long, four feet wide and four feet deep, and consists of a series of eight compartments, each measuring twenty-two inches square. The exhaust enters from the top of one cell and empties through the bottom into the next cell, finally emerging at the top. Around these two eight-inch pipes a small brick chimney, one and one-half feet square and twenty feet high, was built at the corner of the engine room through which the exhaust escapes into the air. A very faint puffing sound which cannot be heard unless the observer stands within a few feet, and a few heat waves coming out of the top of the chimney are the only indication of its presence.

Thermostatic control on each of the engines guards against any possibility of overheating.

The engines are continually in operation as the plant operates twenty-four hours a day.

The changeover to Diesels one year ago has resulted in a big reduction in plant operating costs. Here is how the power cost of 68 cents per ton using purchased current compares today with using plant current generated by its own Diesels:

4 gallons of fuel oil @ 4c..........	$ .16
.03 gallon of lubricating oil with allowance for oil changes...........	.016
Sinking fund for maintenance.....	.03
Total power cost per ton	$0.206

To make a long story short, Diesels reduced the power cost of this plant *over 70 per cent!*

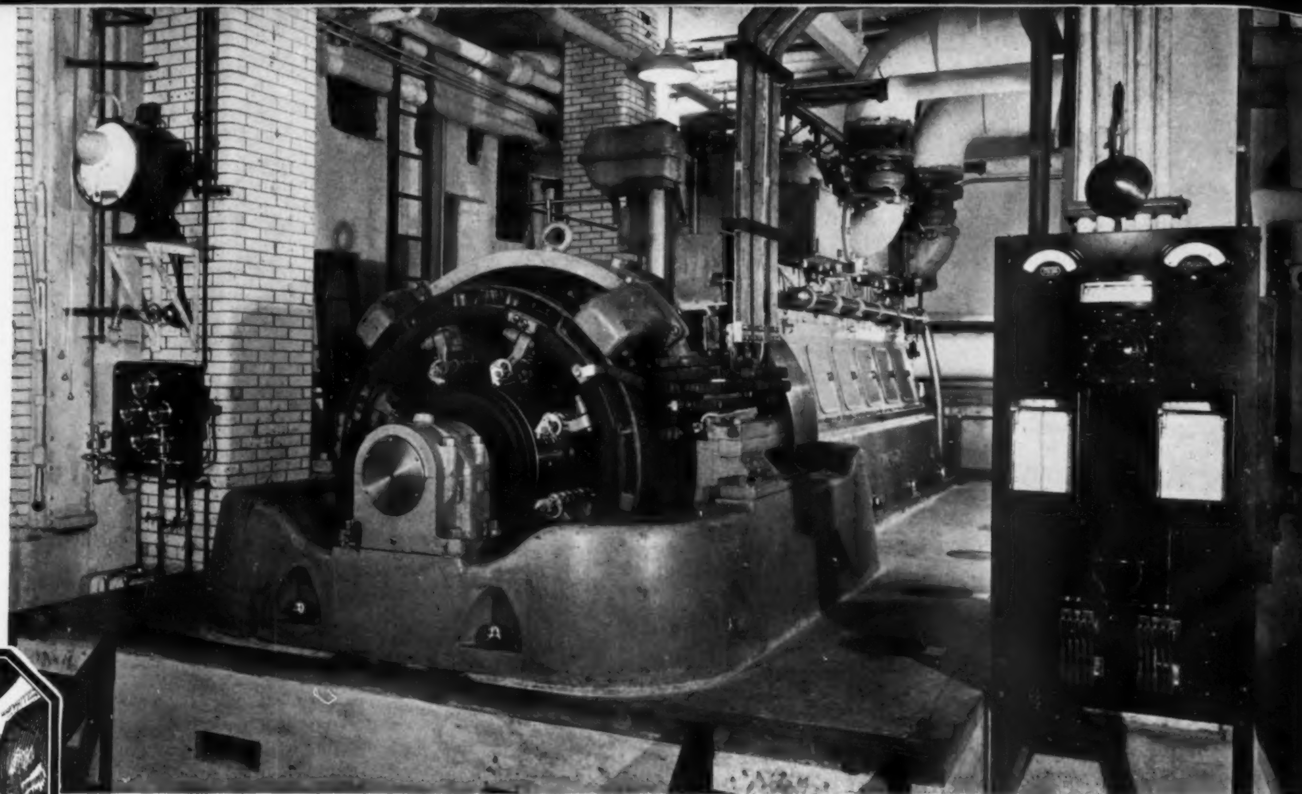
The Chaffee plant, running at full capacity 24 hours a day, has a capacity of 90 tons a day. Each engine consumes in this period 180 gallons of fuel. A 13,000-gallon fuel tank underground just outside the plant is filled from tank trucks right from the street.

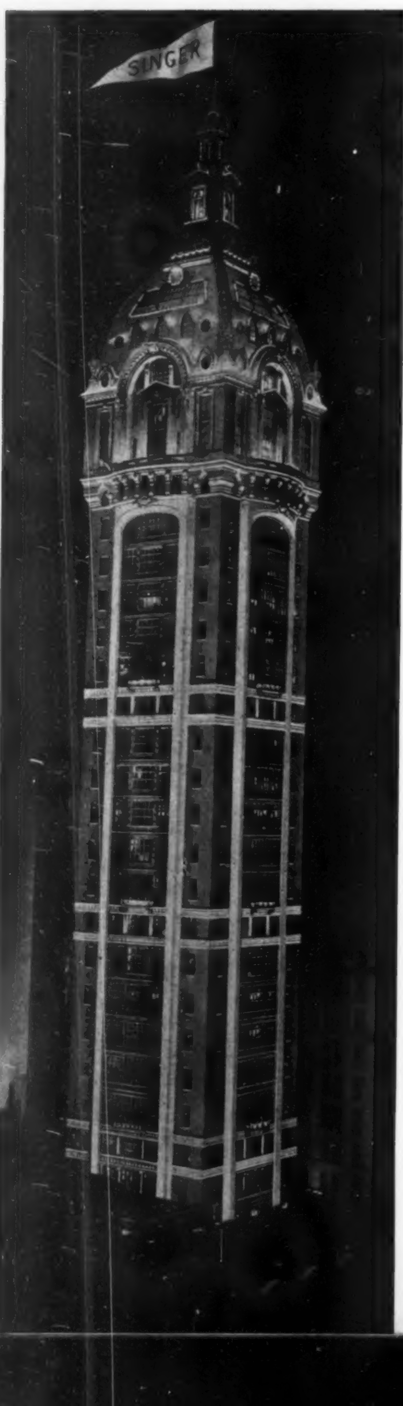
By the addition of a pre-cooling system by which the water used to make ice is first pumped to pre-cooling tanks containing coils through which brine is circulated, Chaffee and his chief engineer expect to increase production now to 100 tons of ice a day.

During periods when the full capacity of the plant is not necessary, it may be run on only one of the Diesel engines at a fuel cost per ton of $0.148 and a lubricating oil cost per ton of $0.014. This is due to the fact that when only one compressor is working the brine temperature rises and the pressure increases, thus allowing a production of fifty tons of ice every 24 hours on one engine alone. On the other hand, if purchased power were used the cost per ton would increase because of the higher rates for less current consumed, instead of being less as in the case of a Diesel equipped plant.

As Chaffee sells his entire output to dealers direct, serving Providence, East Providence, Warren, Bristol and a part of Pawtucket, he has no marketing problem to worry about.

And with his own Diesel operated power plant furnishing current for all his electric needs instead of being dependent on outside power he has no power problem to worry about now, either.





SATCO* BEARINGS
in the Singer Building Power Plant

ALTHOUGH the Singer Building in New York is generally regarded as the pioneer in the tower-type of office building, its power plant "has never been permitted to grow old." It is, in fact, more modern than plants in many newer buildings.

A six-cylinder Winton Diesel engine has been installed in the Singer Building to drive a Diehl generator, rated at 350 kw., to furnish electricity at low cost. The Winton Diesel is a six-cylinder, 14" x 16", four cycle, solid injection machine, rated at 525 bhp. at 375 rpm.

Satco-lined bearings of our fabrication are used in this engine to insure long, trouble-free service. Our experience in manufacturing bearings intended for hard, exacting work, under heavy pressures and high operating temperatures, is at your command.

---

*A patented alloy manufactured by National Lead Company. Trademark registered.

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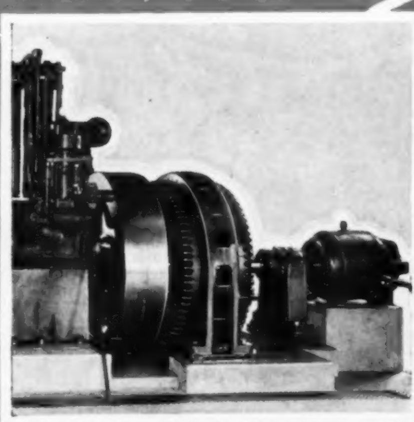
Details count....

Elliott Generators



for Diesel power

ECo

....in

GENERATORS for Diesel drive

Add up the comparatively minor points in generator design—niceties of frame construction, of spider design, of armature winding details, of twenty other different elements—total up these factors, and you have a condition which very often spells the difference between complete success and only passable performance in a Diesel installation.

It is these factors—relatively unimportant individually, but vitally important collectively—which are never lost sight of in the building of Elliott Generators. It is this unremitting attention to detail which assures to every efficient, dependable Diesel driving an Elliott Generator, that its valuable qualities will be faithfully reflected in low operating costs, and the kind of performance that builds further sales.

Be fair to your Diesels—equip them with Elliott Generators, custom built to the Diesels they serve.

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